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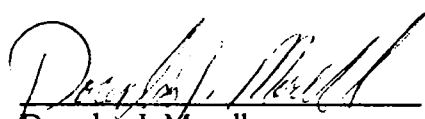


**Golder Associates Inc.**  
CONSULTING ENGINEERS

REPORT TO  
GENERAL ELECTRIC COMPANY

PHASE 3  
REMEDIAL INVESTIGATION  
EAST 4323 MISSION AVENUE  
SPOKANE, WASHINGTON  
VOLUME I

Submitted by  
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## 1. INTRODUCTION

Between July 1987 and January 1988, Golder Associates conducted Phase 3 Remedial Investigation at General Electric's former industrial apparatus service shop located at 4323 E. Mission Ave, Spokane, Washington to assess the extent and type of organic compounds and metals within the subsurface soils and groundwater. Authorization to conduct the investigation was received from General Electric in June, 1987. All work conducted was performed in accordance with the following project plans, which were reviewed and approved by General Electric and the Washington State Department of Ecology: Phase 3 Remedial Investigation-Work Plan, Health and Safety Plan, Quality Assurance Plan, and Sampling and Analysis Plan.

This report discusses the site characteristics, operational history, previous site investigations, and procedures and results of the current remedial investigation.

### 1.1 Site Description

The former industrial apparatus service shop is owned by General Electric and is located approximately 4 miles east-northeast of downtown Spokane along the northern edge of the light industrial sector of eastern Spokane (Figure 1.1). The facility lies on a level terrace approximately 90 feet above and 1200 feet south of the neighboring Spokane River. The adjacent properties include Washington Water Power Company (WWPC) land to the west and south, City of Spokane Havana Street right of way to the west, and private property belonging to Mr. Marvin Riley to the north (Figure 1.2). Access to all of the above properties is restricted by a series of chain link fences and locked gates around the site perimeter. Only the northern boundary of the above properties, adjacent to the Burlington Northern right of way, is unfenced.

### 1.2 Operational History

The industrial apparatus service shop (Figure 1.3) was operated by General Electric (GE) from 1961 to 1980. The shop was used for the repair of industrial and utility equipment, including transformers, and housed a machine shop and repair process facilities. Steam cleaning of equipment was performed in the western and northern portions of the shop and associated runoff was collected in the west dry well and north sump respectively. The western portion of the facility was originally outdoors, covered in 1962, and completely enclosed in 1967. Transformers were stored in outside areas to the south and west of the shop and in storage rooms added to the west end of the shop in 1968. The warehouse facility and grounds to the north of the service shop were leased by GE from Mr. Marvin Riley between 1975 and 1980 and used for the repair of electrical equipment including transformers, above ground storage of transformer oils, and the manufacture of motor coils.

## 2. PREVIOUS SITE INVESTIGATIONS

### 2.1 Initial Site Inspection

On October 15th, 1985, a Site Inspection was conducted by the Washington Department of Ecology (WDOE) along with representatives of General Electric (GE) and Bechtel National Inc.(BNI). Seven samples were collected from the service shop dry wells and surface soils adjacent to the building and analyzed for polychlorinated biphenyls (PCBs) and priority pollutant metals. While elevated concentrations of PCBs were found in most of the samples, the highest concentrations (1000-7000 ppm) were associated with the west dry well and the transformer storage area along the southwest corner of the building. Elevated concentrations of copper, lead, and zinc were also detected in the west dry well and south floor pit areas.

### 2.2 Phase 1 Site Investigation

A more detailed sampling program was conducted by BNI during June and July of 1986 (BNI, 1986a) including both surface and subsurface sampling. The sample location points are shown in Figure 2.1. Soil samples were collected from the surface to 3 feet below ground surface at 53 sample trenches located on both the GE shop site and adjacent properties belonging to WWPC and Mr. Riley. Vertical sample holes, centered within the major dry wells and sumps, were advanced to depths of 21.2 feet (west dry well), 16.1 feet (north sump), and 12.0 feet (south floor pit) below the concrete floor. Continuous drive samples were obtained from these holes. Additional sludge and/or water samples were taken from three secondary sumps and one empty storage tank. Analyses for PCBs (EPA method 8080) and priority pollutant metals were conducted on selected soil and sludge samples obtained during the sampling program. A liquid sample obtained from one of the secondary sumps was also analyzed for volatile organics (EPA methods 601/602).

Little (less than 1 ppm) or no PCBs were detected in the surface and near surface soils along the eastern and southern portions of the site. Moderate PCB concentrations (1 to 100 ppm) were generally detected in the surface soils to the north, west, and southwest of the service shop. The highest concentrations of PCBs were detected in surface soils near the southwest corner of the service shop (1800 to 27,000 ppm) and are associated with former transformer storage areas. Isolated high PCB concentrations (200 to 2800 ppm) were also found at 2 to 3 feet below ground surface approximately 150 feet northwest of the shop and were later found to be associated with an overflow drainage pipe from the west dry well. The distribution of maximum PCB concentrations in the near surface soils is shown in Figure 2.2. The concentrations of PCBs were generally found to diminish rapidly with increasing depth. Only two soil samples contained over 6 ppm PCB at a sample depth of 3 feet.

While PCBs were detected in all of the subsurface drill hole samples, generally low concentrations (2 to 20 ppm) were found beneath both the north sump and south floor pit

areas. Below a depth of 10 feet no PCB concentrations greater than about 2 ppm were measured in these two areas. Beneath the west dry well area, however, PCB concentrations were all greater than 2000 ppm and as high as 21,000 ppm. These high concentrations reflect the primary use of the west dry well for the collection of steam cleaning wastes. Furthermore, the maximum PCB concentration was at a depth of 21.2 feet which was the maximum drill depth attained beneath the west dry well. Concentrations of PCB in the sump sludge samples ranged from 4.3 ppm to 72 ppm. The highest concentration is associated with the north sump which was used to collect some cleaning wastes. The precipitate sample collected from the empty storage tank in the service shop contained 641 ppm of PCB.

Concentrations of priority pollutant metals detected in both the surface and subsurface soils were generally near background concentrations. Elevated concentrations of copper, lead, and zinc were both isolated and minor in occurrence. Elevated concentrations of copper, lead, and zinc were found in all of the sludge samples obtained from the vertical drill holes but not in the associated subsurface soil samples. These concentrations were considerably higher in the south floor pit area (which also contained elevated concentrations of silver) presumably due to its proximity to the machine shop area. These elevated concentrations result from the presence of metal shavings and filings within the sludge material.

Volatile organics detected within the liquid sump sample from the west dry well included toluene (20 ppb), xylene (660 ppb), 1,1-dichloroethane (12 ppb), and 1,1,1-trichloroethane (400 ppb). These volatiles are all associated with industrial solvents used by the service shop.

### 2.3 North Warehouse Site Investigation

In July of 1986, additional investigations of the north warehouse facility were conducted by BNI (BNI, 1986b) to assess PCB concentrations in areas not covered by the Phase 1 Site Investigation. Samples were collected inside the east end of the warehouse including 6 concrete core samples from the warehouse floor, 4 wipe samples from the warehouse walls, two sludge samples from sumps used to collect steam cleaning wastes, and one composite soil sample from soils beneath 3 of the concrete core locations. Two samples were ground from the top 1/2 inch of the core samples. All samples were analyzed for PCB (EPA method 8080). PCB concentrations in the top 1/4 inch and the second 1/4 inch of the concrete core samples ranged from 19 to 91 ppm and less than 0.1 to 64 ppm, respectively. The underlying soil composite contained only slight concentrations of PCBs at 0.2 ppm. Sump sludges also contained moderate PCB concentrations of 31 and 33 ppm. The wipe samples contained between 0.008 and 0.14 ug/sq.cm. of PCB and three of the four samples contained less than 0.014 ug/sq.cm. of PCB.



## 2.4 Phase 2 Site Investigation

During October and November of 1986 a second detailed sampling and monitoring program was conducted by BNI (BNI, 1987). This investigation included evaluation of groundwater characteristics at the site and neighboring vicinity, collection of additional surface and subsurface soil samples, and evaluation of building structure contamination.

The evaluation of groundwater characteristics included a collection and review of published reports and well log data, and a survey of neighboring wells. A summary of the information obtained on characteristics of the underlying Spokane Valley-Rathdrum Prairie aquifer is presented in Section 4.2 and hence is not repeated here. The well survey identified the existence of approximately 50 wells in the four square mile area surrounding the site. Of these 50 wells, however, only 19 could be located during the well survey. Two of the located wells are downgradient of the site; one is used solely as a monitoring well and the other is reportedly abandoned.

A total of five monitoring wells were installed at the GE site including one upgradient (background) well and four downgradient wells. The location of these wells is shown in Figure 2.3. All of the wells were installed by Ponderosa Drilling Co. using an air rotary rig (CP650WS). Six inch diameter steel cased borings were drilled to between 70 and 78 feet and wells were completed using 4 inch diameter well casing and screen to a total depth of between 70 and 73 feet (approximately 10 feet below the water table). Each well casing string consisted of 10 feet of stainless steel wire wrapped 0.040 inch screen, 15 feet of stainless steel riser pipe, and 45 to 50 feet of Schedule 40 PVC riser pipe. No sand pack was installed for these wells, instead, the 6 inch steel casing was pulled back 25 feet, following installation of the well casing, to allow the formation to cave against the well casing. In areas of known PCB surface concentrations (Wells MW2, MW4, and MW5), 8 inch steel casing was first installed to a depth of 15 feet above the water table and 6 inch steel casing was telescoped inside the 8 inch casing.

The monitoring wells were developed and purged using a submersible electric pump. Water samples were collected using a stainless steel bailer. Steam cleaning was used to decontaminate both the pump and bailer. No other decontamination procedures were used. Water samples collected were analyzed for PCBs (EPA method 608) and volatile organics (EPA method 624). The only compounds detected in the samples were 20 ppb of trichloroethylene in MW2 and 2.6 ppb of PCB Aroclor 1260 in MW5. Well MW5 is located immediately downgradient of the west dry well area. The detection limit for PCBs was 0.5 ppb. Water levels measured during the sampling round indicated a groundwater flow direction of N55W to N75W and an average horizontal gradient across the site of about 0.0013 ft/ft.

Soil samples were collected from shallow sample pits and trenches, 3 of the monitoring well borings, and a single drill hole inside the building (Figure 2.3). Trenches were dug to trace and examine buried overflow pipes connected to sumps and dry wells within the building. Of greatest significance was the identification of an overflow pipe from the west dry well to a buried, gravel filled, steel drum about 180 feet west northwest of the dry well. Additional

sample pits were dug in areas of suspected high PCB soil concentrations including areas adjacent to concrete pads along the north side of the building, the drain line and discharge point for the west dry well, and suspected areas of ponding identified by aerial photography along the west side of the building. A single drill hole was advanced to a depth of 33.4 feet about 40 feet east of the west dry well inside the shop. Drive samples were taken at 5 foot intervals using a modified California sampler. Drive samples were also obtained with a modified California sampler at 5 foot intervals to 40 feet followed by 10 foot intervals to 60 feet during the drilling of monitoring wells MW2, MW4, and MW5.

Selected soil samples were analyzed for PCBs (EPA method 8080) and/or volatile organic compounds (EPA method 8240). Samples collected from the shallow sample pits generally exhibited moderate concentrations of PCB in the surface soil (up to 700 ppm) and rapidly diminishing concentrations of PCB with depth. Higher concentrations of PCBs (100 to 3500 ppm) were detected near the northwest corner of the service shop (designated P34) and the west dry well overflow discharge point (designated P36). While PCB concentrations at these two locations did appear to diminish with increasing depth, significant concentrations (940 and 160 ppm, respectively) were still present at depths of 3 and 6 feet, respectively. Low concentrations of PCBs (less than 20 ppm) were detected in samples associated with trenches T2 and T3. Samples from the sump (S7) located east of the north warehouse (a collection sump for two sumps within the eastern portion of the warehouse) exhibited PCB concentrations of 74 and 216 ppm. PCB concentrations within the subsurface drive samples collected from the interior drill hole and monitoring wells MW2, MW4, and MW5 were all less than 0.11 ppm below a depth of 7 feet. Only the surface soil sample from MW2 (244 ppm) contained PCB concentrations above 10 ppm. The distribution of maximum PCB concentrations in the near surface soils is presented in Figure 2.4.

No significant concentrations of volatile organics were observed in the samples selected for EPA 8240 screening during Phase 2 investigation. One soil sample collected near the west dry well overflow collection point (P36-4.5 foot depth) indicated the presence of toluene (150 ppb) and xylene (estimated at 1200 ppb). Xylene was also present in the sludge sample collected from the collection sump (S7) located east of the north warehouse. Both methylene chloride (420 to 700 ppb) and trichlorofluoromethane (140 to 580 ppb) were detected in 6 of the 12 drive samples obtained during drilling and analyzed for volatile organics. The fact that these compounds are found in relatively constant concentrations, do not exhibit any spatial pattern or correlation with other compounds, were not known to be used at the GE service shop, and are common solvents used by analytical laboratories suggests that their presence is a result of contamination by the analytical laboratory and not soil chemistry.

Concrete core and soil samples were collected from and directly below the building floor at 13 locations (Figure 2.3). An additional six surface wipe samples were collected from the building walls and ceilings. All of the collected samples were analyzed for PCBs to assess building structure contamination. The top 1/4 inch of the concrete core samples were ground up and used for the PCB analysis. All of the core samples from the west dry well (steam cleaning) area and one sample adjacent to the south dry well contained PCB concentrations of 1600 to 2700 ppm. Core samples from all other areas of the building contained only 54 ppm to 760 ppm PCBs. Surface wipe samples contained between 0.02 and

0.09 ug/sq.cm. and did not exhibit any spatial correlation with the west dry well or other areas. Soil samples collected from beneath the concrete floor showed elevated concentrations of PCBs in the immediate vicinity of both the west dry well (600 to 4000 ppm) and north sump (10 to 1300 ppm).

### 3. PHASE 3 REMEDIAL INVESTIGATION APPROACH AND PROCEDURES

#### 3.1 Remedial Investigation Objectives

The principal objective of the remedial investigation conducted by Golder Associates was to evaluate the extent of identified organic compounds and metals in the subsurface soil and groundwater. Specifically this included evaluation of the vertical and lateral extent of organic compounds in the soils of the west dry well area, identification of which compounds (PCBs, volatile and semivolatile organic compounds) were present and mobile in the subsurface environment, and evaluation of the extent and direction of chemical transport from the west dry well area via the groundwater.

#### 3.2 Drilling and Sampling

A total of 7 exploratory borings were drilled on the GE service shop site and adjacent properties to the west (Figure 3.1). Six of the borings were completed as monitoring wells including one double well completion. All of the borings were drilled using the air rotary method and driven steel casing. Borings GA1, MW6, MW7A, MW8, and MW10 were drilled by FLD Industries using a modified Mobile B-40 truck mounted rotary drill rig, Atlas Copco 850 cfm air compressor, and Tigre Tierra pneumatic casing hammer. An Odex air percussion bit was used as an underreamer to advance the casing through boulders. The remaining borings were drilled by Allbery Drilling Corp. using a CP750WS air rotary rig and 1800 lb. casing hammer. All of the borings were vertical except GA1 which was drilled at an angle of 15 degrees to vertical.

Return circulation was channeled via flexible hose through a cyclone and cuttings were collected in either 500 gallon catch basins or 55 gallon drums. When drilling in the enclosed west dry well area, exhaust air from the cyclone was channeled outside of the building and drill cuttings were misted with tap water to reduce dust and worker exposure. Cuttings were drummed, drained when necessary, labeled as to hole number and depth, and stored on pallets inside the service shop. Drilling water, including water drained from cuttings drums, was collected and stored in a 30,000 gal Modutank reservoir installed inside the service shop.

Cuttings samples were collected at 5 foot intervals and drive samples were obtained at 5 to 20 foot intervals (depending on hole location) using a 2.5 inch split spoon drive sampler equipped with a spring core catcher. Drive samples were occasionally unobtainable due to the presence of boulders and/or cobbles. Surface grab samples were also collected prior to the start of each hole. Collected samples were placed in clean glass jars with teflon lined lids and labeled as to hole number, depth, date and time of collection, person collecting the sample, preservatives used, and sample type. Duplicate archive samples were collected for all samples from borings MW6 and MW8 except when limited drive sample recovery did not provide a sufficient amount of sample. Collected samples were temporarily stored in insulated coolers and subsequently placed in a locked refrigerator until analyzed on site or

shipped off site under chain of custody to the analytical laboratory. Samples were shipped via overnight delivery in insulated and sealed sample shuttles containing reusable ice packs. A few selected samples were hand delivered to a local laboratory for PCB analysis during periods when on site analysis was not available. Each sample was given a sample identification number which was coded to identify the sample boring, sample type, and sample depth from ground surface. Sample types were coded as: G for surface grab sample, C for drill cuttings sample, and D for split spoon drive sample. For example, sample MW6-C-5.0 corresponds to a drill cuttings sample from boring MW6 at a depth of 5.0 feet below ground surface.

The drilling of each boring was supervised by a Golder engineer and detailed boring and drilling logs recorded. The boring logs included a description of subsurface stratigraphy (based on the Unified Soil Classification System), sample locations, and other pertinent information such as weather conditions. Copies of the boring logs are presented in Appendix A. Drilling logs included a complete record of activities conducted at each hole.

The drilling equipment, casing, and drill rigs were steam cleaned at the start of the drilling program and between holes to prevent cross contamination. Only approved drilling lubricants (vegetable oil or teflon grease) were used for all downhole equipment to prevent the introduction of petroleum hydrocarbons. Supplied air was filtered to remove compressor oil, moisture, dirt, and other potential contaminants. All drive and surface sampling equipment was decontaminated using a four stage procedure: wash with Alconox cleaning solution, tap water rinse, reagent grade hexane rinse, distilled water rinse.

All drilling, sampling, and logging procedures were conducted according to the applicable Golder technical procedures: TP-1.2-5, TP-1.2-6, TP-1.2-18 and TP-1.2-21 as presented in the project Quality Assurance Plan. Further details of the drilling and sampling methods used are presented below.

### 3.2.1 West Dry Well Borings

To determine the extent of soil contamination in the west dry well area, three borings were drilled inside the building (Figure 3.2). One vertical boring (MW6) was drilled immediately adjacent to and northwest of the west dry well to a depth of 120 feet below the building floor. A second vertical boring (MW8) was drilled about 10 feet west northwest of the dry well to a depth of 81.5 feet. The third boring (GA1) was drilled about 20 feet southwest of the west dry well, inclined at an angle of 75 degrees from the horizontal towards the dry well, to a total length of 62.5 feet (60.4 feet below the floor surface). Borings MW6 and MW8 were drilled using 8 inch steel casing to a depth of 53 and 60 feet respectively and completed using 5 inch steel casing to total depth. To obtain sufficient vertical clearance for operation of the drill rigs, portions of the west bay roof were removed and later replaced.

Drive samples were taken at approximately 5 foot intervals in boring MW6 and at 10 foot intervals in borings MW8 and GA1. All samples collected from MW6 and MW8 were scanned with a Foxboro organic vapor analyzer (OVA) calibrated daily to a 10 ppm methane standard. Odors of organic vapors (tentatively identified as chlorinated benzenes)

were frequently noticed during the drilling operations within the west dry well area. Consequently, OVA readings were also taken at the wellhead and in the vicinity of the drilling operations during the collection of each drive sample for MW6 and MW8. Unfortunately the OVA has a low sensitivity to chlorinated benzenes. As a safety precaution, respirators were worn during the drilling activities in this area. One air sample of cuttings exhaust was also collected during the drilling of MW6 and analyzed on site for volatile organics. Two samples were collected in the driller's breathing zone, during an on site inspection by the project health and safety officer, to evaluate worker exposure risks. A 3M Model 3500 passive dosimeter was used to sample for total hydrocarbons. A glass fiber filter/florisil tube and air sampling pump were used to sample for PCBs according to NIOSH Method 5503.

### 3.2.2 Outside Borings

Four vertical borings were installed along an arc approximately 250 feet from the west dry well (Figure 3.1) to determine the extent of chemical migration from the dry well area. Borings MW7A and MW10 were drilled using 5 inch casing and borings MW9 and MW11 were drilled using 6 inch casing from surface to total depth. Boring MW7 encountered a boulder at shallow depth and was abandoned due to deviation of the hole. Borings MW7A, MW9, MW10 were drilled to 80 feet and boring MW11 was drilled to 160 feet. Three drive samples were taken in the vadose zone at each boring location at approximately 10, 30, and 50 feet. Due to the close proximity of MW9 and MW11 these borings were treated as one boring location and drive sample locations were staggered between the two holes. Additional drive samples were generally taken at five foot intervals between 60 feet (top of the water table) and 80 feet at each boring location.

### 3.3 Well Installation

All six of the vertical borings were completed as monitoring wells. Borings MW7A, MW8, MW10, and MW11 were completed as shallow wells screened at the water table (screen interval of approximately 60 to 75 foot depth). Boring MW6 was completed about 40 feet below the water table (screen interval of approximately 102 to 117 foot depth). Boring MW9 was completed as two wells, MW9U at 50 feet below the water table (screen interval of approximately 114 to 119 foot depth) and MW9L at 90 feet below the water table (screen interval of approximately 147 to 157 foot depth). The well completion details are summarized in Table 3.1.

All wells were completed using 2 inch well casing and screen. Stainless steel wire wrapped 0.02 inch screen and flush coupled well casing was used from total depth to approximately 10 feet above the water table. Schedule 40 PVC flush coupled casing was used for the remaining well casing. A sand pack of 10/20 Colorado Silica was installed adjacent to each screen and volclay or bentonite cement grout was used to fill the remaining well annulus. Both the sand pack and grout filler were installed in stages inside the 5 or 6 inch steel conductor casing, during casing removal, to minimize caving of the formation. The steel

conductor casing was withdrawn to approximately 10 feet above the water table in each boring during well completion. The well and conductor casing were extended 2 to 3 feet above ground surface, fitted with a locking steel cap, and painted. For the outside wells, a triangular concrete pad with 3 steel bumper posts was installed. Detailed diagrams of individual well completions are presented in Appendix B.

All wells were installed according to the applicable Golder technical procedures: TP-1.2-12 and TP-1.2-22 as presented in the project Quality Assurance Plan.

### 3.4 Well Development and Sampling

All of the newly installed on site wells (MW6 through MW11) were developed by air lifting following well completion. Air lifting was unable to create water production in the shallow wells, although agitation of the screen sand pack was feasible, since a portion of the well screen lay above the water table. Shallow wells were agitated in this manner for a minimum of 10 minutes. The deeper wells were developed until the discharge water exhibited acceptable clarity. All development discharge water was collected and disposed of in the Modutank water inside the service shop.

All of the on site wells (MW1 through MW11) were developed and purged using a development tool available from Instrumentation Northwest. This unit consisted of a simple check valve assembly attached to a string of 3/4 inch PVC and was operated by an air driven piston pump mounted on a portable tripod. Well discharge was collected in 55 gallon drums and disposed of in the Modutank reservoir inside the service shop. Discharge was periodically sampled and cumulative discharge, pH, conductivity, temperature, dissolved oxygen content, and clarity were measured and recorded. A minimum of three well volumes were purged from each well. While all quantitative parameters generally stabilized rapidly, some wells required purging greater than three well volumes to achieve acceptable clarity. Records of measured discharge parameters are presented in Appendix C.

A total of 6 well development units (check valve assembly and 3/4 inch PVC pipe) were used during the sampling round. To prevent cross contamination all units were cleaned between wells using an Alconox detergent wash followed by a tap water rinse. Additionally development units were used in what was believed to be the cleanest wells first and dedicated (not reused) in the wells potentially containing the greatest amount of chemical compounds. The order of well sampling was: MW1, MW7A, MW3, MW4, MW2, MW5, MW10, MW6, MW8, MW9U, MW11, MW9L. Dedicated units were used in wells MW5, MW6, MW8, MW9L, and MW11.

Water samples were taken using a stainless steel bailer equipped with a teflon check valve. The bailer was cleaned prior to sampling each well using a four step process: Alconox detergent wash, tap water rinse, hexane rinse, organic free distilled/deionized water rinse. Due to the low water solubility of hexane and the low ambient air temperature, the bailer was heated with a radiant heating element, following the hexane rinse, to volatilize residual hexane. The nylon cord used to lower the sample bailer was discarded between holes to

prevent cross contamination. In wells MW8 and MW5, a clear teflon bailer was lowered prior to well development to check for the existence of floating product, however, no product was found. Decontamination procedures for the clear bailer were identical to that for the stainless steel bailer.

Sample containers and preservatives used in the well sampling round are identified in Table 3.2. Samples collected for metals analysis were filtered with a 0.45 micron and 5.0 micron filter respectively. Two groundwater samples were collected from each well for PCB analysis: centrifuged and non-centrifuged. Sample centrifuging was performed by the laboratory performing the sample analysis. Filtering of metals samples and centrifuging of PCB samples was performed to allow discrimination between chemicals contained in the solid (soil) and liquid (water) phases.

Solutions for field spikes were prepared locally by ABC Laboratories. The volatile organic spikes (EPA method 601/602) were injected, using a 10 ul syringe, through the septum cap sample vials to minimize sample loss. The PCB spikes (EPA method 8080) were measured using a 0.5 ml syringe and injected directly into the collected sample. Metals spikes were measured using a 25 ml graduated cylinder. All sample spikes were stored in a locked refrigerator.

Each sample container was labeled identifying well number, depth at which sample was taken, date and time of collection, person collecting sample, and preservatives used. Each sample was given a sample identification number which was coded to identify the sample well, sample type, depth of sample collection from ground surface, and sample analysis. Sample types were coded as: W for water sample, PB for procedural blank, and TB for travel blank. Sample analyses were coded as: 601 for EPA method 601, 602 for EPA method 602, 418.1 for EPA method 418.1, PCB for EPA method 608, M5.0 (5 micron filtered) and M0.45 (0.45 micron filtered) for copper, lead, and zinc analysis, and PM5.0 (5 micron filtered) and PM0.45 (0.45 micron filtered) for priority pollutant metals analysis. The suffixes: D for duplicate, S for field spike, and QC for internal laboratory QA/QC sample duplicates, were added to the sample analysis codes where applicable. For example, sample MW8-W-72-M5.0S corresponds to a spiked water sample taken at a depth of 72 feet below ground surface in well MW8, filtered with a 5.0 micron filter, and analyzed for copper, lead, and zinc.

All collected samples were temporarily stored in insulated coolers and subsequently placed in a locked refrigerator until shipped off site under a chain of custody to the analytical laboratory. Samples were shipped via overnight delivery in insulated and sealed sample shuttles containing reusable ice packs. All samples were shipped within 48 hours of collection.

All groundwater samples were collected according to the applicable Golder technical procedure: TP-1.2-14 as presented in the project Quality Assurance Plan.



### 3.5 Chemical Analyses

#### 3.5.1 Soil Analyses

Soil samples collected, including surface grab samples, split spoon drive samples, and drill cuttings samples, were selectively analyzed for volatile organics, chlorinated benzenes, polychlorinated biphenyls (PCBs), petroleum hydrocarbons, copper, lead, zinc, and priority pollutant metals.

The majority of soil samples were analyzed on site using a Hewlett Packard 5890 gas chromatograph. This temporary field laboratory was set up in the offices of the former service shop and operated by Farr, Friedman, and Bruya (FFB) under contract to Golder Associates. Analyses were conducted on selected samples for volatile organics, tri- and tetrachlorinated benzenes, and total PCBs (expressed as Aroclor 1254). Analyses for the chlorinated benzenes and PCB, were conducted using an HP-1 megabore column and electron capture detector. A total of 151 samples were analyzed for chlorinated benzenes and PCBs including all soil samples collected, with the exception of cuttings samples at or above 50 feet in borings MW9, MW10, and MW11. Analyses for the volatile organics were conducted using a J&W DB624 megabore column and flame ionization detector. A total of 65 soil samples were analyzed for volatile organics including all surface and subsurface samples collected from borings GA1 and MW6.

Details of the methods used for the analyses and results obtained are presented in Appendix D. Further details of the analysis methods used are presented in the following references: Farr and Gorelik, 1983; Spittler, 1983.

To confirm the on site analyses and provide additional contaminant screening, 9 soil samples were sent to Analytical Technologies Incorporated (ATI) for laboratory analysis. All 9 samples were analyzed for PCBs (EPA method 8080) and volatile organics (EPA method 8010 and 8020). Eight of the samples were analyzed for petroleum hydrocarbons (EPA method 418.1), and copper, lead, and zinc (EPA methods 6010 and 7421). One of the samples was analyzed for chlorinated hydrocarbons (EPA method 8270) and priority pollutant metals (EPA methods 6010, 7041, 7060, 7131, 7421, 7471, 7740, and 7841). An additional 4 samples were hand delivered to ABC Laboratories in Spokane for rapid turnaround PCB analysis (modified EPA method 8080) to assess potential health risks and required health and safety measures for drillers operating in the outside areas. Details of the results from these analyses are presented in Appendix E.

#### 3.5.2 Groundwater Analyses

All groundwater analyses were conducted by Analytical Technologies Incorporated (ATI), a participant in the EPA Contract Laboratory Program (CLP), using standard EPA methods. A listing of the groundwater samples collected, including quality control field samples is presented in Table 3.3.

### 3.5.3 Other Analyses

Two water (MT-W-1 and MT-W-2) and two sediment (MT-S-1 and MT-S-2) samples were collected from the modutank inside the building following completion of the drilling program and transfer of all water collected from the decon stations. These samples were analyzed for PCBs (EPA methods 608 and 8080) by ABC Laboratories of Spokane. Analyses of air and airborne dust samples collected for health and safety assessments were analyzed for total hydrocarbons and PCBs by Hagar Laboratories, an accredited AIHA laboratory. Details of the results from these analyses are presented in Appendix E.

### 3.5.4 Quality Assurance and Control

The on site (FFB) laboratory results were subject to both internal and external quality assurance and control procedures. Internal quality control included sample replicates and duplicates, matrix spikes, method blanks, and daily calibration with known standards. For the chlorinated benzene and PCB analyses, a total of 12 replicates, 14 duplicates, 6 matrix spikes, and 7 method blanks were analyzed. For the volatile organic compounds, a total of 4 replicates, 4 duplicates, and 12 method blanks were analyzed. External quality control included sample duplicates analyzed by Analytical Technologies, an independent laboratory, and an on site inspection and procedural review by Golder Associate's analytical chemist.

The off site (ATI) laboratory results were also subject to both internal and external quality assurance and control procedures. Internal quality control included matrix spikes and reagent (method) blanks. In general one matrix spike was conducted for each type of analysis performed for each sample shuttle received. One reagent blank was also tested for the volatile organic and PCB analyses conducted on each shuttle. External quality control included the analysis of groundwater sample duplicates and field spikes for wells MW5 and MW8, one field procedure blank, and one travel blank as shown in Table 3.3. No external quality control was provided for the off site soil analyses.

### 3.6 Site Survey

A site survey was performed by Adams and Clarke of Spokane. This survey included: location and elevation of Phase 3 monitoring wells; location of service shop building corners; site elevation measurements over a 50 foot grid; preparation of a site topographic map. Monitoring well elevations included ground surface (or concrete pad surrounding well), reference scribe mark on protective steel casing, and top of PVC well casing. Locations of surface sample pits were determined by Golder Associates from published sample location drawings (Bechtel, 1986a; 1987) using reference survey locations and an X-Y digitizer. These results are presented in Appendix F.

## 4. PHASE 3 REMEDIAL INVESTIGATION RESULTS

### 4.1 Geology

The service shop site is underlain by unconsolidated soils generally consisting of nearly equal percentages of well graded sand and gravel, 5-10 per cent silt, and less than 5 per cent clay and organic material. Clay content is generally higher in the upper 1 to 2 feet of soil due to weathering and soil formation. Considerable variation in relative sand and gravel contents is infrequently observed ranging from 10 per cent coarse sand/90 per cent gravel to 90 per cent sand/10 per cent fine gravel. The gravel fraction consists predominately of subrounded to subangular grey quartzite, and occasionally whitish to light grey granite, fragments. Cobbles and boulders of similar source materials are commonly encountered. The sand fraction is typically pale to moderate yellowish brown quartz grains. Detailed logs of subsurface stratigraphy are presented in Appendix A.

The unconsolidated soils beneath the site are estimated to be 350 to 400 feet thick based on limited seismic and drill hole data (Bolke and Vaccaro, 1981). These deposits extend from the Rathdrum Prairie area of Idaho, west past Spokane. The soils were deposited in a very high energy environment during periods of catastrophic flooding associated with failure of the ice dam forming Lake Missoula during the last glacial period.

### 4.2 Hydrology

Average annual precipitation at the site is about 20 inches per year. Average monthly precipitation ranges from less than 1 inch during the summer months to over 2 inches during the winter months. Between the months of December and February most of the precipitation occurs as snow although warming periods and melting of snow cover are common (U.S. Army Corps of Engineers, 1976).

The sand and gravel deposits underlying the site are part of the Spokane Valley-Rathdrum Prairie aquifer which is the sole source of drinking water in Spokane. This formation was officially designated as a sole-source aquifer by the EPA in 1978. The hydraulic characteristics of the aquifer have been studied by the USGS (Bolke and Vaccaro, 1979, 1981; Drost and Seitz, 1978) and the Corps of Engineers (US Army Corps of Engineers and Kennedy-Tudor Engineers, 1976). Hydraulic conductivity of the aquifer is estimated to be between 0.02 and 0.04 ft/sec in the vicinity of the service shop. Based on an estimated saturated thickness of 300 feet at the site location, the transmissivity of the aquifer is between 6 and 12 sq.ft./sec. The general groundwater flow direction is from east to west, paralleling the Spokane Valley (Figure 4.1). Downgradient of the site most of the groundwater flow turns towards the north through the Hillyard Trough, crossing underneath the Spokane River. Computer simulations indicate that the upper portion of the aquifer discharges into the Spokane River (Bolke and Vaccaro, 1981; Vaccaro and Bolke, 1983) at this crossing. Estimated groundwater velocity is approximately 20 to 30 feet per day underneath the site.

Measurements of water table elevations in the shallow on site monitoring wells indicate the groundwater flow direction to range between N10W and N110W (Figure 4.2). Towards the southern portion of the site groundwater flows in a westerly direction, however, towards the northern portion of the site groundwater flows in a more northerly direction.

The horizontal flow gradient steepens immediately west of the former service shop. Between the upgradient well MW1 and well MW8 near the west dry well the average horizontal gradient is about 0.0007 ft/ft. Between well MW8 and well MW11 at the western site boundary the horizontal gradient is about 0.0019 ft/ft or nearly three times as great. Measured vertical gradients are greater in magnitude than the corresponding horizontal gradients. In the west dry well area the vertical gradient is about 0.0032 ft/ft downward (4-5 times the horizontal gradient) within the upper 40 feet of the water table. Near the western boundary at wells MW9 and MW11, the vertical gradient is about 0.0021 ft/ft downward within the upper 50 feet of the water table and about 0.0017 ft/ft upward between 50 and 85 feet below the water table. Higher vertical gradients are frequently observed in sedimentary deposits due to low vertical to horizontal hydraulic conductivity ratios.

The rounded surface of the groundwater table around the service shop area, the increase in groundwater gradients west of the service shop and the existence of downward vertical gradients in the upper portion of the aquifer suggest the existence of a groundwater recharge source near the shop area. Although the existence of such a source is not evident from physical information on the site it may result from the collection and diversion of runoff from the building roof and surrounding paved area. Curvature of the groundwater surface is influenced to some degree by discharge of the upper aquifer into the Spokane River some 1200 feet to the north, however, this effect should be more regional in scale and would not conform with the contours of the facility. The existence of permeability contrasts, caused for example by subsurface paleochannels, may also distort groundwater contours and flow directions. A high permeability channel may exist at depth as evidenced by a gravel and cobble zone between 115 and 141 feet in boring MW9. Such a channel could explain the apparent rounded surface of the water table, the existence of downward vertical gradients between about 70 and 110 feet, and upward vertical gradients between 110 and 145 feet below ground surface. Large and continuous stratigraphic contrasts were generally not observed during logging of the shallower borings.

#### 4.3 Soil Chemistry Results

Results of all chemical analyses conducted on collected soil samples by on site (FFB) and off site (ATI and ABC) laboratories are presented in Appendices D and E, respectively. Discussion of these results is presented below.

#### 4.3.1 Volatile Organic Compounds

All surface and subsurface samples collected from borings GA1 and MW6 were screened for volatile organics using on site (FFB) laboratory capabilities. A total of one sample from boring GA1, six samples from MW6, and one sample from MW11 were also tested for volatiles by an off site (ATI) laboratory. Due to the removal of volatile organics by the air rotary method, sample analyses should be considered qualitative and not quantitative.

Seven volatile organic compounds were identified from the on site analyses: 1,2-dichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, hexane, ortho-xylene, para-xylene, and ethyl-benzene. A large response due to an unidentified compound was also occasionally observed in conjunction with samples containing xylene.

The presence of hexane, tetrachloroethylene, and 1,2-dichloroethylene are all chiefly attributed to on site laboratory contamination. Hexane was detected in all but one sample at concentrations generally ranging between a few tens to a few hundreds of parts per billion. The presence of hexane is attributed to its use as a solvent for both drive sampler decontamination and PCB extraction. Hexane was found to be present at similar concentrations in all but one of the method blanks. Tetrachloroethylene was found in 68 per cent of the samples tested, generally at concentrations of about 10 ppb or less. Similar concentrations of tetrachloroethylene were also detected in four of the six water method blanks. Water method blanks are those blanks run with the distilled/deionized water used to prepare soil samples for volatile analysis. Its presence in the water method blanks suggests that this compound is associated with tetrachloroethylene contamination of the water used to prepare the volatile samples. It is interesting to note that concentrations of tetrachloroethylene were highest (up to 87 ppb) for the MW6 soil samples between 14 and 33.5 feet (i.e. beneath the west dry well) suggesting that some tetrachloroethylene may actually be present in the soil near the west dry well. 1,2-dichloroethylene was present in only two of the samples tested. Its presence is correlated with the two highest concentrations of hexane measured and therefore is believed to represent an associated laboratory induced contaminant.

Ortho- and para-xylene were detected in samples from both GA1 and MW6 at depths of 0 to 40 feet and 60 to 74 feet. The highest concentrations were found between 5 and 23 feet in boring MW6 (i.e. immediately below the west dry well). These results indicate that xylenes are concentrated both in soils adjacent to and below the west dry well and at the water table. Ethylbenzene was also detected in the two samples containing the highest xylene concentrations at depths of 5.0 and 8.4 feet in MW6. A third unidentified volatile organic compound was present in 7 samples tested and is associated with xylene concentrations between 5 and 33.5 feet in MW6. 1,1,1-trichloroethane was found at the surface and a depth of 8.4 feet in MW6. An air bag sample of the cuttings exhaust, taken during the drilling of MW6, indicated the presence of 1,2-dichloroethylene and 1,1-dichloroethane.

Six volatile organic compounds were identified in the soil samples sent for off site analysis by ATI: tetrachloroethylene, 1,1,1-trichloroethane, toluene, xylene, benzene, and methylene chloride. Four of the seven compounds: tetrachloroethylene, 1,1,1-trichloroethane, toluene,

and xylene were only detected in the surface grab sample from MW6. Benzene was detected in the MW6 samples at 18.5 and 28.0 feet. Methylene chloride was detected in one MW6 sample at 69 feet. This compound is a common laboratory induced contaminant. Results of the off site laboratory analyses for volatile organics are summarized in Table 4.1.

#### **4.3.2 Polychlorinated Biphenyls (PCBs) and Chlorinated Benzenes**

All soil samples collected, with the exception of cuttings samples at or above 50 feet in borings MW9, MW10, and MW11, were analyzed using on site laboratory facilities (FFB) for chlorinated benzenes and PCBs. Nine samples including one sample from GA1, six samples from MW6, one sample from MW10, and one sample from MW11 were tested by an off site laboratory (ATI) for PCBs. One sample from MW6 was also tested by ATI for chlorinated hydrocarbons including chlorinated benzenes (EPA method 8270). Four soil samples from the outside borings were tested off site by ABC Laboratories for PCBs.

The PCB concentration profiles for the borings in the west dry well area are shown in Figure 4.3. Adjacent to the west dry well (boring MW6) and to a depth of about 35 feet, PCB concentrations are all greater than 100 ppm and generally greater than 1000 ppm. Below this depth, PCB concentrations were considerably less, ranging between 10 and 100 ppm. PCB concentrations also dropped off considerably below about 70 feet. Only one drive sample indicated concentrations of PCB greater than 1 ppm below 70 feet. The associated cuttings samples decreased from about 40 ppm to 2 ppm over the interval 70 to 105 feet. This gradual decline in the associated cuttings samples probably reflects some carry over of PCB contamination from the hole casing, cuttings exhaust line, and cyclone. Below 105 feet PCB concentrations were all less than the detection limit of 1 ppm.

The lateral dispersion of PCBs in the vadose zone soils beneath the dry well appears to be limited. PCBs were not detected in the angled boring (GA1) at a distance greater than about 15 feet from the dry well center. In the neighboring vertical boring MW8, located 2 feet north and 9 feet west of MW6, significant PCB concentrations were found only in the near surface soils. The maximum concentration was found at the surface (160 ppm), dropping to less than 1 ppm below 20 feet. This suggests lateral dispersion from the dry well area beneath the concrete floor rather than via the subsurface soils. Sporadic, small concentrations of PCB (less than 10 ppm) were detected at 35, 40, 55, and 80 feet below ground surface in boring MW8.

Only low concentrations of PCBs (generally less than 3 ppm) were detected in the surface and subsurface borings outside the building. These concentrations, shown in Table 4.2, are limited to the surface and near surface soils or within soils near the water table. PCBs were detected in the surface soils at all three boring locations outside of the building at concentrations of 1 to 2 ppm. Cuttings samples from MW7A also indicated PCB concentrations of less than 3 ppm to a depth of 15 feet. Two subsurface samples from MW11 at 60 feet and one from MW10 at 55 feet indicated low concentrations of PCBs (2.3 to 24 ppm).

Off site laboratory analyses by ATI for PCBs generally exhibited good agreement with on site analyses by FFB. These results are summarized in Table 4.3. These analyses indicated only the presence of Aroclor 1260 with the exception of one sample which also contained Aroclor 1242.

On site analyses for chlorinated benzenes included 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, 1,2,(3,4),5-tetrachlorobenzene and 1,2,3,4-tetrachlorobenzene. 1,2,3,4-tetrachlorobenzene was the most prevalent of the five chlorinated benzenes although all were generally found to be present. These compounds exhibited very strong correlation with PCB concentrations, as shown in Figure 4.4, and hence the previous discussion regarding PCB distribution applies to these compounds as well. An unidentified compound, suspected to be hexachlorobenzene, was also evident in the gas chromatograms in association with high concentrations of these chlorinated benzenes.

One sample from MW6 at a depth of 18.5 feet was also tested by Analytical Technologies for semivolatile organics (EPA method 8270) including chlorinated benzenes. 1,2,4-trichlorobenzene was detected in this sample at 1.4 ppm as were traces of hexachlorobenzene. Additional major compounds identified in this scan, but not quantified, included tetra- and pentachlorobenzene and di- through octachlorobiphenyl.

#### 4.3.3 Metals and Total Petroleum Hydrocarbons

Soil samples sent to Analytical Technology were also analyzed for metals and petroleum hydrocarbons. Only the surface soil sample from MW6 exhibited elevated metals concentrations (371 ppm copper, 368 ppm lead, and 536 ppm zinc). The concentrations of total petroleum hydrocarbons were significantly elevated in 2 samples from boring MW6: 8600 ppm at ground surface and 1400 ppm at 28.0 feet. The concentrations of petroleum hydrocarbons in the remaining samples ranged between 14 and 78 ppm. These concentrations correlate with the distributions of organic compounds previously described.

#### 4.3.4 Quality Control Samples

The on site laboratory internal quality control samples included sample replicates, sample duplicates, matrix spikes, and daily standards. These results are detailed in Appendix D. The results of sample replicates, sample duplicates, and matrix spikes for PCBs are summarized in Table 4.4. These results indicate good repeatability of replicate and duplicate results. PCB sample spikes, however, generally exhibit poorer agreement. The values are still very reasonable, however, and indicate excellent instrument sensitivity even at low concentrations of PCB. Comparison of on site and off site laboratory results previously presented in Tables 4.1 and 4.3 also show good agreement, particularly for PCB analyses. Volatile organic analyses generally indicate the off site analyses yielded greater concentrations than the on site analyses.

## 4.4 Groundwater Chemistry Results

Results of all water analyses performed by Analytical Technologies are presented in Appendix E. Concentration of all organic compounds and metals detected in the analyses are summarized in Table 4.4. Discussion of these results is presented below.

### 4.4.1 Volatile Organic Compounds

Three volatile organics were detected at low concentrations in the groundwater: tetrachloroethylene, 1,1,1-trichloroethylene, and benzene. All three of these compounds were not detected in either the procedure or travel blanks. Tetrachloroethylene was found at very low concentrations (less than 0.75 ppb) in all of the wells except MW3, MW9U and MW9L. While generally higher concentrations (0.5 to 0.7 ppb) were associated with wells adjacent to or downgradient of the west dry well area (MW2, MW5, MW6, MW8, MW10, and MW11) the observed concentrations are very low and only slightly higher than observed for the upgradient well MW1 (0.45 ppb). 1,1,1-trichloroethane was also found at very low concentrations (less than 0.33 ppb) in all wells except MW1, MW7A, MW9U, and MW9L. All measured concentrations of 1,1,1-trichloroethane are barely above the detection limit of 0.2 ppb and no systematic spatial variation is observed. Benzene was detected only in the vicinity of the well cluster MW9L, MW9U, and MW11. The highest level of benzene was 5.6 ppb in well MW9U which is just above the maximum contaminant level (MCL) of 5.0 ppb. Benzene may exist as a degradation product of chlorinated benzenes or ethylbenzene. The fact that all three of these wells, and no others, were installed by the same drilling company also suggests the possibility that benzene may have been artificially introduced during well drilling or installation. It is of importance to note that trichloroethylene, previously detected in groundwater from well MW2 at 20 ppb during the Phase 2 sampling round, was not detected in the current sampling round.

Volatile and semi-volatile organic compounds detected in the GC/MS analyses (EPA methods 624 and 625) of water samples from MW6 and MW8 are shown in Table 4.6. All of these compounds are detected at very low concentrations and are believed to represent introduced contaminants. Bis(2-Ethylhexyl)Phthalate is a commonly introduced contaminant in water samples and is derived from plastic containers used to store distilled rinse water. Hexane was used to rinse the sample bailer and its presence is attributed to this practice. Similarly, branched alkanic acid and branched alcohol may be associated with the Alconox detergent used to wash the sampling equipment. The source of ethyl cyclobutane and pyrene are uncertain, however, these compounds are found at very low concentrations. None of the compounds detected in the standard EPA 601/602 analyses were detected in the EPA 624/625 analyses due to the higher detection limits of the latter analyses.



#### 4.4.2 Polychlorinated Biphenyls (PCBs)

PCBs (Aroclor 1260) were detected in wells MW5, MW8, and MW11. The concentration of PCBs within centrifuged groundwater from well MW5 downgradient of the west dry well area is close to the solubility limit of Aroclor 1260 in water of 2.7 ppb at 20 degrees C (Verschuran, 1983). The average concentration of the uncentrifuged MW5 groundwater sample is also close to that observed during the Phase 2 water sampling round (2.6 versus 2.5 ppb) that was unfiltered. Concentrations within the centrifuged samples are significantly less for wells MW8 and MW11 indicating that much of the PCB concentration is associated with the solid (soil) phase and not the liquid (water) phase. Suspected PCB congeners were noted for samples taken from wells spatially adjacent to wells containing PCB including MW6, MW9U, MW9L, and MW10. No PCBs were detected in either the travel or procedural blanks.

#### 4.4.3 Metals and Total Petroleum Hydrocarbons

Petroleum hydrocarbons were detected in all of the sampled groundwaters at very low concentrations (less than 1 ppm) with the exception of MW7A (17 ppm). The lowest concentration was found in the upgradient well MW1 (0.06 ppm). A very low concentration (0.07 ppm) was also observed in the procedural blank.

Lead and zinc were the only metals detected in the groundwater samples collected. Lead concentrations were extremely low (0.002 to 0.007 ppm) and detected in only 2 wells, MW1 and MW7A. Zinc was also found at very low concentrations (0.01 to 0.20 ppm) in all but two wells, MW3 and MW9U. No significant differences in metals concentrations were observed between the 0.45 and 5.0 micron filtered samples indicating detected metals are dissolved within the water phase. The concentration of zinc is spatially correlated with the west dry well area wells MW2, MW5, MW6, MW8 and the downgradient wells MW10 and MW11. Zinc was detected in concentrations at or near the detection limit (0.01 ppm) in both the procedural blank and upgradient well, but not in the travel blank. Lead was not detected in either the procedural or travel blanks but was detected in the upgradient well, MW1.

#### 4.4.4 Quality Control Samples

Off site laboratory groundwater analyses included both internal and external quality control samples. These results are presented in detail in Appendix E. Results of the field spike samples are shown in Table 4.7. Spike concentrations are based on the analysis of the spiking solution concentration by ABC Laboratories of Spokane, who supplied the spiking solutions, and the relative volume of spiking solution to sample volume. Excellent agreement is indicated between spiked concentrations and analytical results for the EPA method 601 compounds and metals (copper, lead, and zinc). Analytical results for the EPA method 602 compounds are generally significantly lower than the spiked concentrations. This is probably a direct result of the longer holding time (18 days) for the method 602 spiked samples and consequent sample loss. None of the other water samples collected,

including the unspiked samples, were subjected to holding times of greater than 7 days. Results of the PCB (EPA method 608) sample spikes are inconclusive as the background PCB concentrations are significantly greater than the added spike concentrations.

#### **4.5 Other Chemistry Results**

##### **4.5.1 Total Organic Content**

The total organic content of soils beneath the water table was determined for 5 selected soil samples by Am Test Laboratories of Redmond, Washington. These results, summarized in Table 4.8, range from 324 ppm to 1210 ppm. These very low organic contents are consistent with the high energy depositional environment for the soils. Measurements of total organic content were used to assess chemical retardation ( $K_d$ ) factors as discussed in Section 5.3.

##### **4.5.2 Modutank Samples**

Two water and two sediment (soil) samples were collected from the Modutank used to collect water produced during the drilling activities. These samples were analyzed for PCBs (EPA methods 608 and 8080) by ABC Laboratories of Spokane. Although no PCBs were detected within the water samples, PCB concentrations of 14 ppm Aroclor 1242, 34 ppm Aroclor 1260 and 108 ppm Aroclor 1242, 403 ppm Aroclor 1260 were detected in the two sediment samples. These results are presented in Appendix E.

##### **4.5.3 Health and Safety Samples**

One air sample and one airborne dust sample sent to Hagar Laboratories were analyzed for total hydrocarbons and PCBs respectively to assess worker exposure during drilling activities within the service shop. Total hydrocarbons were measured at 7 mg/cu.m. which is considerably less than the threshold limit value of 40 mg/cu.m. Total PCBs were determined to be less than 0.02 mg/cu.m. compared to a threshold limit value of 0.5 mg/cu.m. These results indicate that no significant health risks were incurred by workers during drilling activities inside the service shop. The laboratory report is presented in Appendix E.

## 5. SUMMARY AND CONCLUSIONS

Site investigations at the GE Mission Ave service shop have further delineated the extent of organic compounds and metals in the surface soils, the subsurface soils, and the groundwater. The findings of the Phase 3 Remedial Investigation and the two previous investigations are summarized below.

### 5.1 Distribution of Identified Compounds

#### 5.1.1 Volatile Organic Compounds

Volatile organic compounds, including 1,1,1-trichloroethane, tetrachloroethylene, xylenes, benzene, and toluene have been detected at the service shop site. Volatile organic compounds have been detected in the majority of sumps, dry wells, and other drainage and liquid storage structures associated with both the former service shop and north warehouse. Despite the prevalence of these compounds within the facility, the presence of these compounds within the surface and subsurface environment appears to be limited. The soils immediately adjacent to the west dry well and overflow drain appear to contain significant concentrations of volatile organics. Volatile organic compounds appear to be concentrated in the immediate vicinity of the west dry well to a depth of about 35 feet below the shop floor. They are also present in soils at or near the water table below the west dry well. Tetrachloroethylene, 1,1,1-trichloroethane, and benzene are the only volatile organic compounds detected in the groundwater. Both tetrachloroethylene and 1,1,1-trichloroethane are found at extremely low concentrations (less than 1 ppb) and occur over a sufficiently widespread area to suggest their presence is largely a result of background concentrations in the aquifer. Benzene has been detected in low concentrations at or below the maximum concentration level (MCL) of 5 ppb in three of the perimeter wells (MW9U, MW9L, and MW11) downgradient of the west dry well. It is recommended that additional groundwater sampling and analysis for benzene be conducted to understand the observed concentrations.

#### 5.1.2 Polychlorinated Biphenyls (PCBs) and Chlorinated Benzenes

Polychlorinated biphenyls and chlorinated benzenes are the most pervasive organic compounds at the site. Chlorinated benzenes are closely associated with the presence of PCBs. PCBs have been detected in surface and near surface soils at concentrations in excess of 1 ppm to the west, north, and south of the former service shop as shown in Figure 2.4. Concentrations greater than 10 ppm occur over a wide area to the north and west of the service shop, and along the western and southwestern borders of the shop and surrounding paved area. Concentrations greater than 1000 ppm occur in soils beneath the concrete floor adjacent to the west dry well and north sump structures, adjacent to the concrete pad along the southwest corner of the shop, and in the vicinity of the west dry

well overflow outlet. In general, PCBs are confined to the surface soils and diminish to below 1 ppm at a depth of 3 feet.

Vertical migration of PCBs has occurred within the soils beneath the west dry well and near the overflow outlet of the west dry well. Concentrations of PCBs observed at depths of 3, 4, 4.5, 5 and 6 feet (the maximum depth of investigation) near the west dry well overflow outlet (P36) are 1392, 151, 3528, 264 and 158 mg/kg, respectively. Beneath the west dry well, PCBs have migrated vertically to the water table although the concentration decreases sharply from above 1000 ppm to about 100 ppm at a depth of between 30 and 40 feet beneath the shop floor. PCB's appear to be migrating slightly toward the southwest in the vadose zone instead of directly vertical. This may be a result of the heterogeneity of the soils or the west dry well construction. The concentration of PCB in soil also drops significantly at the water table. PCBs were also detected (see Table 4-2) in soils near the water table in two of the three perimeter wells (MW10 and MW11) to the west of the former service shop.

The distribution of PCBs and PCB congeners in the groundwater phase is shown in Figure 5.1. Only two wells immediately downgradient of the west dry well (MW5 and MW8) contained quantifiable concentrations of PCBs (greater than 0.09 ppb). It is important to note that PCBs were quantifiable only in wells screened at the water table surface and exhibit considerably lower concentrations in centrifuged versus non-centrifuged samples. Centrifuged samples reflect PCB concentrations dissolved within the mobile liquid (water) phase, while non-centrifuged samples include PCB concentrations adsorbed to the solid phase (soil particles). Measured concentrations in the water phase are close to the solubility limit downgradient of the west dry well (MW5). PCB congeners were detected below quantifiable concentrations in wells downgradient, laterally adjacent to and beneath wells (MW5 and MW8) containing quantifiable concentrations of PCB's. PCB congeners may represent a portion of a specific aroclor at concentrations less than 0.1 to 0.05 ppb.

### 5.1.3 Metals

High concentrations of lead, copper, and zinc have been detected in the sumps and dry wells of the former service shop. Concentrations of these metals in adjacent soils, however, are low and generally indistinguishable from background concentrations. Zinc is present in the groundwater at extremely low concentrations (0.06 to 0.20 ppm) adjacent to and immediately downgradient of the west dry well (wells MW2, MW5, MW6, MW8, MW10, and MW11). Lower concentrations (<0.01 to 0.04) are observed in all other wells. While zinc concentrations are spatially correlated with the west dry well, the concentrations are well below levels of environmental concern.

## 5.2 Migration Mechanisms

The migration of organic compounds from the service shop appears to be primarily associated with steam cleaning activities. This migration is the result of both the movement

of steam cleaning waste water runoff through drainage structures, across paved/concrete surfaces, and possibly airborne transport by steam cleaning mists. Although both the west dry well and north sump areas were used for the collection of steam cleaning wastes, it is evident that the former was the principal area of collection and the only identified area of significant vertical migration. Both PCBs and volatile organic compounds were transported by waste waters from the west dry well area in three ways (listed in order of importance): 1) downward migration through the base of the unlined dry well to the water table, 2) transport via the dry well overflow line to a buried drain (gravel filled steel drum) approximately 180 feet west of the dry well, and 3) lateral migration along the interface between the concrete shop floor and the underlying soil. During steam cleaning operations, the west dry well is reported to have often overflowed (BNI, 1986a) and hence often contained standing water.

The characterization of downward migration from the west dry well within the vadose zone depends upon both boundary conditions at the base of the dry well and the unsaturated flow characteristics of the underlying soil. Given the known accumulation of sludge at the base of the west dry well it is anticipated that the rate of wastewater infiltration is controlled by seepage through the sludge material and is therefore independent of the standing water head within the dry well (Bouwer, 1978). Infiltration from a cylindrical cavity under a controlled seepage (prescribed flux) boundary condition has been studied in some detail by Phillips (1968). The shape of the wetting front emanating from the dry well is strongly dependent on the relative importance of matric (or capillary) and gravitational forces during infiltration. In coarse grained soils, such as those underlying the west dry well, gravitational forces predominate, the wetting front is narrow and elongated in shape, moisture content decreases more rapidly with depth (Figure 5.2). The distribution of PCBs beneath the west dry well (Figure 4.3) reflects the moisture content distribution of Figure 5.2 for a coarse grained soil.

Concentrations of organic compounds near the west dry well overflow drain and beneath the concrete floor near the west dry well result from periodic overflow of the dry well. Dispersion of organic compounds in soils near the overflow drain has likely been by capillary diffusion. Movement of waste water beneath the concrete floor surrounding the west dry well has probably been by saturated flow along the floor/soil interface and capillary diffusion into the underlying soil during overflow of the dry well. The extent of chemical migration in these latter two areas appears to be limited. Due to the low solubility of transformer oils and their constituents including PCBs and chlorinated benzenes, it would seem reasonable that these oils were transported as a liquid emulsion of transformer oil droplets in the waste water phase. The fact that the concentration ratio of PCBs to chlorinated benzenes remains relatively constant in all of the soil samples tested beneath the west dry well supports this hypothesis.

The low concentrations of PCBs over areas to the north, west, and south of the service shop may result from airborne transport of PCBs by steam cleaning mist. Surface concentrations of PCBs may also have been spread by vehicular traffic and/or waste water runoff from covered areas with subsequent ponding. In general, volatile organics would not be transported by these mechanisms due to volatilization. Local high concentrations of

PCBs near the southwest corner of the shop are believed to result from leakage of transformers reportedly stored in this area.

The migration of PCBs from the west dry well area by groundwater flow is believed to have occurred in two different ways: transport as a floating emulsion or film on the water table surface; and transport as a dissolved groundwater component.

Transport of PCBs and chlorinated benzenes within a light non-aqueous phase liquid (LNAPL) is evidenced by the concentration of PCBs within the soils and groundwater at or near the water table and the existence of measurable PCB concentrations in soils ( $> 1$  ppm) at distances greater than observed for the corresponding dissolved groundwater component. Given the existence of downward vertical gradients within the upper portion of the saturated zone and the higher specific gravity of PCBs and chlorinated benzenes, PCBs would not be expected to concentrate near the water table surface either as a dissolved groundwater component or a separate dense non-aqueous phase liquid (DNAPL). During migration from the west dry well area, the transporting phase was apparently absorbed by soil particles at the water table. This zone of soil adsorption is widened by natural fluctuations in the water table elevation. No evidence of a free floating phase was found in either the west dry well area or the downgradient perimeter wells during the Phase 3 sampling round. The chemistry of the potential floating LNAPL is uncertain, but may have consisted of mineral oil transformer oils and/or organic solvents such as xylenes. This transport mechanism has probably not been active since closure of the facility in 1980.

As a dissolved groundwater component, PCBs migrate very slowly. Due to their low water solubility and high affinity for soils, PCBs spend only brief periods of time as a dissolved component separated by long residence times when they are adsorbed to soil particles. The concentration of dissolved PCBs at any one moment therefore reflects a greater concentration of adsorbed PCBs in the adjacent soil matrix. Immediately downgradient of the west dry well area dissolved PCBs are close to the solubility limit for the water phase indicating higher concentrations within the surrounding soil matrix. Most PCBs associated with the solid (soil) fraction of the collected (uncentrifuged) water samples are considered immobile. The existence of a noticeable fraction of solids, or soil fines, within the water samples is attributable to disturbance of the soil matrix during drilling and installation of the monitoring well and practical limitations on the subsequent development of such wells. Hence the turbidity of collected water samples is much greater than the turbidity of the aquifer groundwater in its undisturbed state.

### 5.3 Migration Rates of Dissolved Polychlorinated Biphenyls

The migration rates of PCB Aroclors 1242 and 1260 in the groundwater system at the former service shop site were estimated from the chemical properties presented in Table 5.1. The log soil/water partition coefficient ( $K_{oc}$ ) was estimated on the basis of three chemical properties of PCBs: solubility in water; log octanol/water partition coefficient ( $K_{ow}$ ); and the first order molecular connectivity ( $^1X$ ). All three methods yielded similar estimates of  $K_{oc}$  as shown in Table 5.1. The distribution coefficient,  $K_d$ , (or ratio of soil concentration to water

concentration) was estimated from the range of  $K_{oc}$  and measured total organic content of the aquifer soils at the site. The solute retardation, or ratio of average groundwater velocity ( $\bar{V}^a$ ) to average solute velocity ( $\bar{V}^s$ ), was determined from  $K_d$  assuming a grain density of  $2.65 \text{ gm/cm}^3$  and a soil porosity of 30% or 0.30.

Estimated average migration rates of PCBs dissolved within the groundwater phase are 3-9 feet per year for Aroclor 1260 and 30-90 feet per year for Aroclor 1242. Analysis of soil samples at the site area indicate 1260 to be the dominant PCB Aroclor present with very isolated and minor amounts of Aroclor 1242 detected. Given that the shop began operation in 1961, the probable average extent of PCB migration is roughly 50 to 150 feet from the source area. This estimate is in close agreement with measured concentrations of PCBs in the groundwater phase. These estimates of PCB migration apply only to PCBs dissolved within the groundwater and not to PCBs potentially transmitted in a LNAPL emulsion or floating phase. It is recommended that monitoring groundwater downgradient of the site should be conducted to delineate PCBs and associated chlorinated benzenes in groundwater.

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**TABLE 3-1**

**WELL COMPLETION DATA**

**Elevations in Feet Above MSL<sup>1</sup>**

Well Number	Top of Well Casing	Ground Surface <sup>2</sup>	Water Level <sup>3</sup>	Screen Interval
MW1	1959.13	1956.08	1889.61	1879.23-1894.23
MW2	1956.46	1954.22	1889.39	1881.85-1896.85
MW3	1957.96	1954.89	1889.30	1880.97-1895.97
MW4	1953.93	1950.77	1889.11	1881.19-1896.19
MW5	1957.14	1954.26	1889.42	1882.13-1897.13
MW6	1955.56	1955.32	1889.35	1838.63-1853.63
MW7A	1952.80	1950.43	1888.89	1879.91-1894.91
MW8	1956.12	1955.34	1889.47	1878.43-1893.43
MW9U	1952.00	1950.17	1888.90	1831.07-1836.07
MW9L	1952.02	1950.17	1888.96	1792.66-1802.64
MW10	1954.93	1952.42	1888.98	1876.05-1891.05
MW11	1951.92	1950.13	1889.00	1875.14-1890.14

<sup>1</sup>Based on City of Spokane datum - (subtract 16.92 feet for current USGS datum, subtract 16.55 feet for 1986 USGS datum, used by BNI)

<sup>2</sup>Elevation of concrete well pad

<sup>3</sup>Measured on 1/28/88

TABLE 3-2

GROUNDWATER SAMPLE CONTAINERS AND PRESERVATIVES

Sample Analysis	Sample Container	Preservative
EPA 601/602	40 ml clear glass vial with teflon lined septum cap	None
EPA 418.1	250 ml brown glass bottle with teflon lined cap	Hydrochloric Acid
EPA 8080	1 liter brown glass bottle with aluminum foil and teflon lined cap	None
Metals	500 ml plastic bottle	Nitric Acid
EPA 624	40 ml clear glass vial with teflon lined septum cap	None
EPA 625	2 liter brown glass bottle with teflon lined cap	None

TABLE 3-3

## GROUNDWATER SAMPLES COLLECTED

Well Number	Volatile Organics (EPA 601/602)	Volatile Organics (GC/MS) (EPA 624)	Semi-Volatile Organics (GM/MS) (EPA 625)	Petroleum Hydrocarbons (EPA 418.1)	PCBs (EPA 608)	Metals (M) Cu, Pb, Zn		Priority Pollutant Metals (PM)	
						5.0um	0.45um	5.0um	0.45um
MW1	X			X	X,C	X	X		
MW2	X			X,A	X,C,A	X	X		
MW3	X			X	X,C,A	X	X		
MW4	X			X,A	X,C	X	X		
MW5	X,D,S			X,D	X,C,A,D,S	X,S	X,D		
MW6	X	X,A	X	X,A	X,C,A			X	X
MW7A	X			X	X,C	X	X		
MW8	X,D,S	X,A	X	X,A,D	X,C,A,D,S	D,S		X	X
MW9U	X			X,A	X,C,A	X	X		
MW9L	X			X	X,C,A	X	X		
MW10	X			X	X,C,A	X	X		
MW11	X			X	X,C,A	X	X		
TRAVEL BLANK (TB)	X			X	X				
PROCEDURE BLANK (PB)	X			X	X	X			

X - Sample Taken, A - Archive Sample Taken for Laboratory QA/QC, C - Sample Taken for Laboratory Centrifuge, D - Duplicate Sample Taken, S - Field Spike Sample Taken

TABLE 4-1

SUMMARY OF OFF-SITE LABORATORY ANALYSES FOR VOLATILE ORGANICS IN SOILS<sup>1,2,3</sup>

Sample Identification	Tetra-Chloroethylene	1,1,1-Tri-Chloroethane	Meta-Xylene	Ortho-, Para-Xylene	Benzene	Toluene	Methylene Chloride
MW6-G-0.0	13 (2.6, 4.5)	37 (17)	96 (ND)	83 (9.7, 11)	<25 (ND)	110 (ND)	<100 (ND)
MW6-D-18.5	<10 (35)	<10 (ND)	<25 (ND)	<25 (6.8)	40 (ND)	<25 (ND)	<100 (ND)
MW6-D-28.0	<10 (ND)	<10 (ND)	<25 (ND)	<25 (1.4)	46 (ND)	<25 (ND)	<100 (ND)
MW6-D-64.0	<10 (8)	<10 (ND)	<25 (ND)	<25 (5.3)	<25 (ND)	<25 (ND)	<100 (ND)
MW6-D-69.0	<10 (10)	<10 (ND)	<25 (ND)	<25 (ND)	<25 (ND)	<25 (ND)	130 (ND)
MW6-D-118.5	<10 (9)	<10 (ND)	<25 (ND)	<25 (ND)	<25 (ND)	<25 (ND)	<100 (ND)
GA1-D-60.0	<10 (6)	<10 (ND)	<25 (ND)	<25 (5.4)	<25 (ND)	<25 (ND)	<100 (ND)

<sup>1</sup>Results are qualitative and used for compound identification only.

<sup>2</sup>Concentrations in ppb - ATI results (FFB results on duplicate samples at same location).

<sup>3</sup>(ND) not detected, no response peak observed on chromatogram screen, detection limit not determined (FFB results only).

TABLE 4-2				
PCB CONCENTRATIONS DETECTED IN OUTSIDE BORINGS				
Boring Number	Depth (feet)	Sample Type	PCBs (ppm) <sup>1</sup>	Analyzing Laboratory
MW7A	0.0	Grab	1.1	FFB
	10.0	Cuttings	1.4	FFB
	15.0	Cuttings	2.6	FFB
MW9	0.0	Grab	2	ABC
MW10	0.0	Grab	2	ABC
	55.0	Cuttings	2.3, 1.1 <sup>2</sup> , 2.5 <sup>3</sup>	FFB
	65.0	Cuttings	0.11	ATI
MW11	60.0	Drive	5.4	ATI
	60.0	Drive	24, 24 <sup>2</sup> , 13 <sup>3</sup>	FFB
	60.0	Cuttings	3.1	FFB
<sup>1</sup> ATI results for Aroclor 1260 (EPA 8080) FFB results for total PCB as Aroclor 1254 ABC results for Aroclor 1260 (modified EPA 8080)				
<sup>2</sup> Replicate Sample				
<sup>3</sup> Duplicate Sample				

**TABLE 4-3****SUMMARY OF OFF-SITE LABORATORY ANALYSES  
FOR PCBs IN SOIL**

Sample Identification	ATI Results (ppm)		FFB Results <sup>1</sup> Total PCB (ppm)
	Aroclor 1260	Aroclor 1242	
MW6-G-0.0	2400	<500	2700, 2200(Dup)
MW6-D-18.5	3200	700	1100
MW6-D-28.0	2900	<500	2800
MW6-D-64.0	4.0	<0.5	21
MW6-D-69.0	0.97	<0.20	12
MW6-D-118.5	<0.1	<0.05	<1
GA1-D-60.0	72	<10	180, 190(Rep)
MW10-C-65.0	0.11	<0.05	<1
MW11-D-60.0	5.4	<1.0	24, 24(R), 13(Dup)

<sup>1</sup>(Rep) = Replicate Sample, (Dup) = Duplicate Sample

**TABLE 4-4****ON-SITE LABORATORY QUALITY CONTROL  
ANALYSES FOR PCBs**

Sample Number	Total PCB Concentration (ppm)			
	Original	Duplicate	Replicate	Matrix Spike (1ppm)
GAI-G-0.0	<1			2
GAI-D-5.0	<1			3.4
GAI-D-20.0	<1	<1		
GAI-D-30.0	18		21	
GAI-D-50.0	27	39		
GAI-D-60.0	180		190	
MW6-G-0.0	2700	2200		
MW6-C-8.4	770		700	
MW6-C-23.0	720		780	
MW6-C-28.0	2600	2900		
MW6-C-53.0	13	11		
MW6-C-79.0	20		21	
MW6-D-79.0	<1		<1	
MW6-C-98.5	2.9		1.6	
MW6-C-118.5	<1	<1		
MW6-D-118.5	<1			1.7
MW7A-D-30.0	<1	<1		
MW7A-D-58.0	<1	<1		
MW8-G-0.0	160	260		170
MW8-D-10.0	36		39	
MW8-C-20.0	9	10		
MW8-D-80.0	<1		<1	
MW10-C-55.0	2.3	2.5	1.1	
MW10-C-65.0	<1			8.0 <sup>1</sup>
MW10-D-80.0	<1			<1



**TABLE 4-4**

**ON-SITE LABORATORY QUALITY CONTROL  
ANALYSES FOR PCBs**

Sample Number	Total PCB Concentration (ppm)			
	Original	Duplicate	Replicate	Matrix Spike (1ppm)
MW11-C-55.0	<1	<1		
MW11-D-60.0	24	13	24	
MW11-C-60.0	3.1		3.8	
<sup>1</sup> 10 ppm matrix spike				

TABLE 4.5

## GROUNDWATER SAMPLE RESULTS

Well Number	Tetra- chloroethylene (ppb)	1,1,1 Tri- chloroethane (ppb)	Benzene (ppb)	Petroleum Hydrocarbons (ppm)	PCB - Arochlor 1260		Lead		Zinc	
					Uncentrifuged (ppb)	Centrifuged (ppb)	5.0 mm (ppm)	0.45 mm (ppm)	5.0 mm (ppm)	0.45 mm (ppm)
MW1	0.45	<0.2	<0.5	0.06	<0.1	<0.1	0.007	0.002	<0.01	0.02
MW2	0.75	0.28	<0.5	0.56	--	<0.1	<0.002	<0.002	0.06	0.06
MW3	<0.2	0.23	<0.5	0.95	<0.1	<0.1	<0.002	<0.002	<0.01	<0.01
MW4	0.28	0.33	<0.5	0.92	<0.1	<0.1	<0.002	<0.002	0.01	<0.01
MW5	0.57	0.20	<0.5	0.29	3.6	3.1	<0.002	<0.002	0.06	0.04
duplicate	0.55	0.27	<0.5	0.23	1.4	--	--	<0.002	--	0.06
MW6	0.51	0.30	<0.5	0.94	<0.5*	<0.5*	<0.002	<0.002	0.11	0.10
MW7A	0.72	<0.2	<0.5	17	<0.1	<0.1	<0.002	0.003	0.03	0.05
MW8	0.51	0.30	<0.5	0.29	1.1	0.09	<0.002	<0.002	0.12	0.11
duplicate	0.33	0.31	<0.5	0.07	0.91	--	<0.002	--	0.10	--
MW9U	<0.2	<0.2	5.6	0.13	<0.5*	<0.1*	<0.002	<0.002	<0.01	<0.01
MW9L	<0.2	<0.2	0.74	0.30	<0.1*	<0.1*	<0.002	<0.002	0.04	0.04
MW10	0.73	0.28	<0.5	0.45	<0.1*	<0.1*	<0.002	<0.002	0.20	0.08
MW11	0.52	0.23	0.71	0.23	0.71	TR (<0.05)	<0.002	<0.002	0.11	0.05
Procedure Blank	<0.2	<0.2	<0.5	0.07	<0.2	--	<0.002	--	0.01	--
Travel Blank	<0.2	<0.2	<0.5	<0.05	<0.1	--	<0.002	--	<0.01	--

TR - Compound detected at concentration below detection limit

\* - Suspected PCB congeners present

TABLE 4-6		
ORGANIC COMPOUNDS IDENTIFIED BY GC/MS ANALYSIS OF GROUNDWATER		
Well Number	Compound	Concentration (ppb)
MW6	Ethyl Cyclobutane	3 <sup>1</sup>
	Hexane	10 <sup>1</sup>
	Bis (2-Ethylhexyl) Phthalate	TR <sup>2</sup>
MW8	Pyrene	TR <sup>2</sup>
	Bis (2-Ethylhexyl) Phthalate	11
	Branched Alkanoic Acid	10 <sup>1</sup>
	Branched Alcohol	50 <sup>1</sup>
<sup>1</sup> Estimated concentration - no standard run <sup>2</sup> TR - compound present at small unquantifiable concentration		

TABLE 4-7

## OFF-SITE LABORATORY EXTERNAL QUALITY CONTROL ANALYSES ON GROUNDWATER SAMPLES

Analysis/Compound	MW5 Original	MW5 Duplicate	MW8 Original	MW8 Duplicate	Concentration of Spike	MW5 Spike	% Recovery	MW8 Spike	% Recovery
EPA 601 (ppb)									
Tetrachloroethylene	0.57	0.55	0.51	0.33	35.6	31	86	35	98
Trichloroethylene	<0.2	<0.2	<0.2	<0.2	8.00	6.2	78	7.7	96
1,1-Dichloroethylene	<0.2	<0.2	<0.2	<0.2	8.28	10	121	11	133
1,1,1-Trichloroethane	0.20	0.27	0.30	0.31	84.5	59	70	75	89
EPA 602 (ppb)									
Benzene	<0.5	<0.5	<0.5	<0.5	10.7	5.9	55	6.7	63
Toluene	<0.5	<0.5	<0.5	<0.5	51.3	13	25	24	47
O&P-xylene	<0.5	<0.5	<0.5	<0.5	91.5	39	43	55	60
EPA 608 (ppb) <sup>3</sup>									
Aroclor 1254	<0.1	<0.5	<0.5	<0.5	0.60	<1.0	N.A. <sup>2</sup>	<0.5	N.A. <sup>2</sup>
Aroclor 1260	3.6	1.4	1.1	0.91	0.12	2.3	N.A. <sup>2</sup>	1.1	N.A. <sup>2</sup>
Metals (ppm) <sup>1</sup>									
Copper	<0.02	---	<0.02	<0.02	1.01	0.93	92	0.93	92
Lead	<0.002	---	<0.002	<0.002	0.98	0.97	99	0.94	96
Zinc	0.06	---	<0.12	0.10	1.02	0.94	92	1.00	98

<sup>1</sup>5.0 micron filtered samples<sup>2</sup>Not applicable due to high detection limit and/or high ambient concentration<sup>3</sup>Uncentrifuged samples

TABLE 4-8			
TOTAL ORGANIC CARBON IN AQUIFER SOILS			
Boring	Depth (ft)	Sample Type	Total Organic Carbon (ppm)
MW6	118.5	Cuttings	662
MW7A	65.0	Drive	417
MW9	65.0	Drive	324
MW9	115.0	Cuttings	814
MW10	70.0	Drive	1210

**TABLE 5-1**

**CHEMICAL AND ADSORPTION PROPERTIES OF PCB-1242 AND 1260 IN  
THE GEOCHEMICAL ENVIRONMENT AT THE GENERAL ELECTRIC MISSION  
AVENUE SITE**

	PCB Aroclor	
	1242	1260
Solubility <sup>1</sup> (mg/l)	0.13-0.34	0.0027
Log Octanol/Water Partition Coeff. <sup>2</sup> ( $K_{ow}$ )	4.1-5.6	6.1-7.1
First Order Molecular Connectivity <sup>2</sup> ( $\chi$ )	8.0	8.8
Log Soil/Water Partition Coeff. ( $K_{oc}$ ):		
a) From Solubility <sup>3</sup>	4.5-4.3	5.5
b) From $K_{ow}$ <sup>3</sup>	3.8-5.2	5.6-6.5
c) From $\chi$ <sup>2</sup>	4.8	5.2
Total Organic Content Soil (% dry wt.)	0.03-0.12	0.03-0.12
Distribution Coefficient <sup>4</sup> ( $K_d$ ):		
a) Total Range	2-190	48-3800
b) Probable Range	20-50	200-500
Solute Retardation <sup>5</sup> ( $\bar{V}_w/\bar{V}_c$ ):		
a) Total Range	12-1200	300-23000
b) Probable Range	120-310	1200-3100
Solute Velocity <sup>6</sup> (ft/year)		
a) Total Range	10-1000	0.5-40
b) Probable Range	30-90	3-9

<sup>1</sup>after Verschuran (1983)

<sup>2</sup>after Sabljic (1986)

<sup>3</sup>after Hassett et al. (1983)

<sup>4</sup>from Freundlich Adsorption Equation

<sup>5</sup>after Freeze and Cherry (1979) assuming a grain density of 2.65 gm/cm<sup>3</sup> and a soil porosity of 30%

<sup>6</sup>based on average groundwater velocity of 30 ft/day



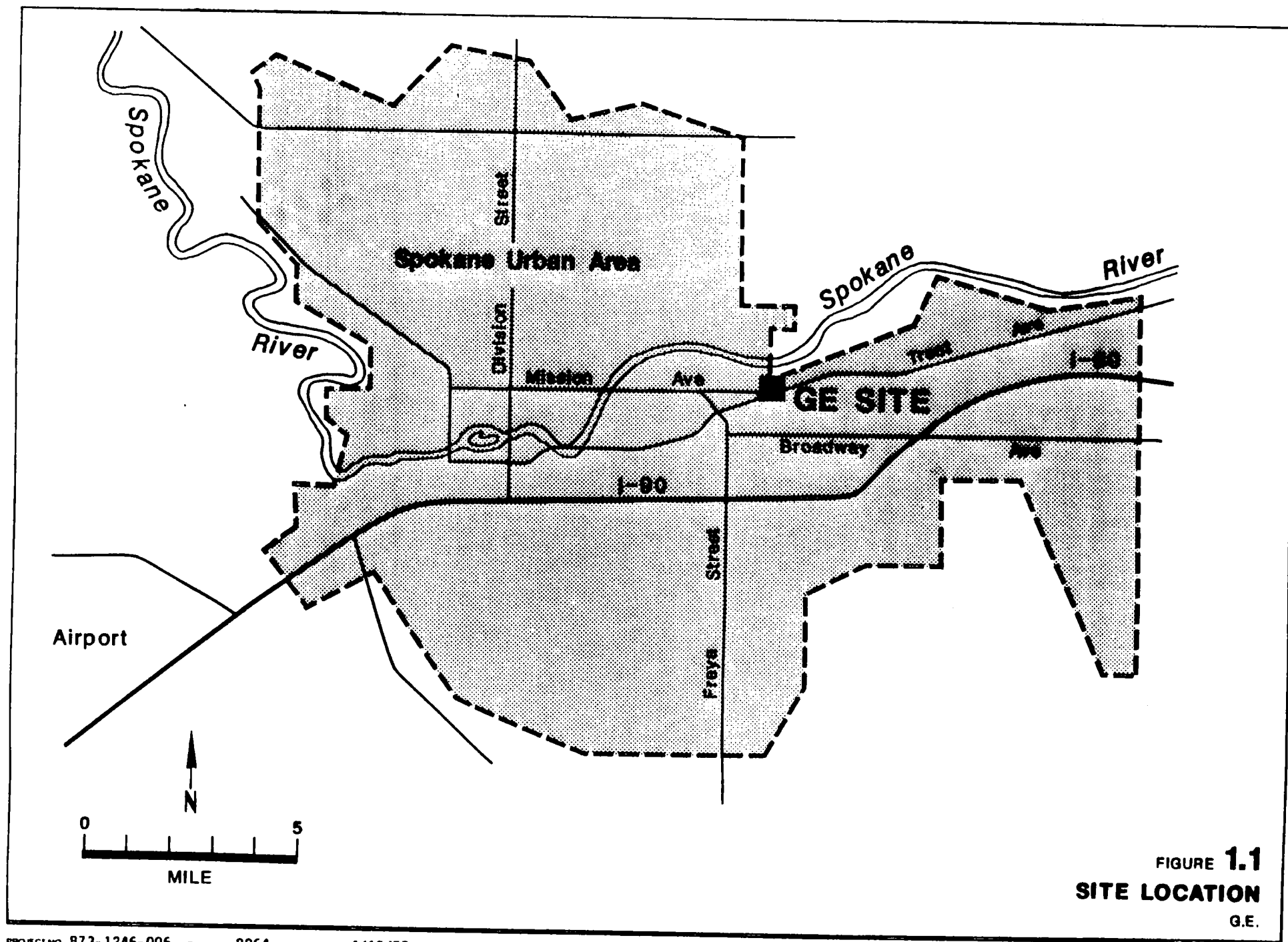


FIGURE 1.1  
SITE LOCATION  
G.E.



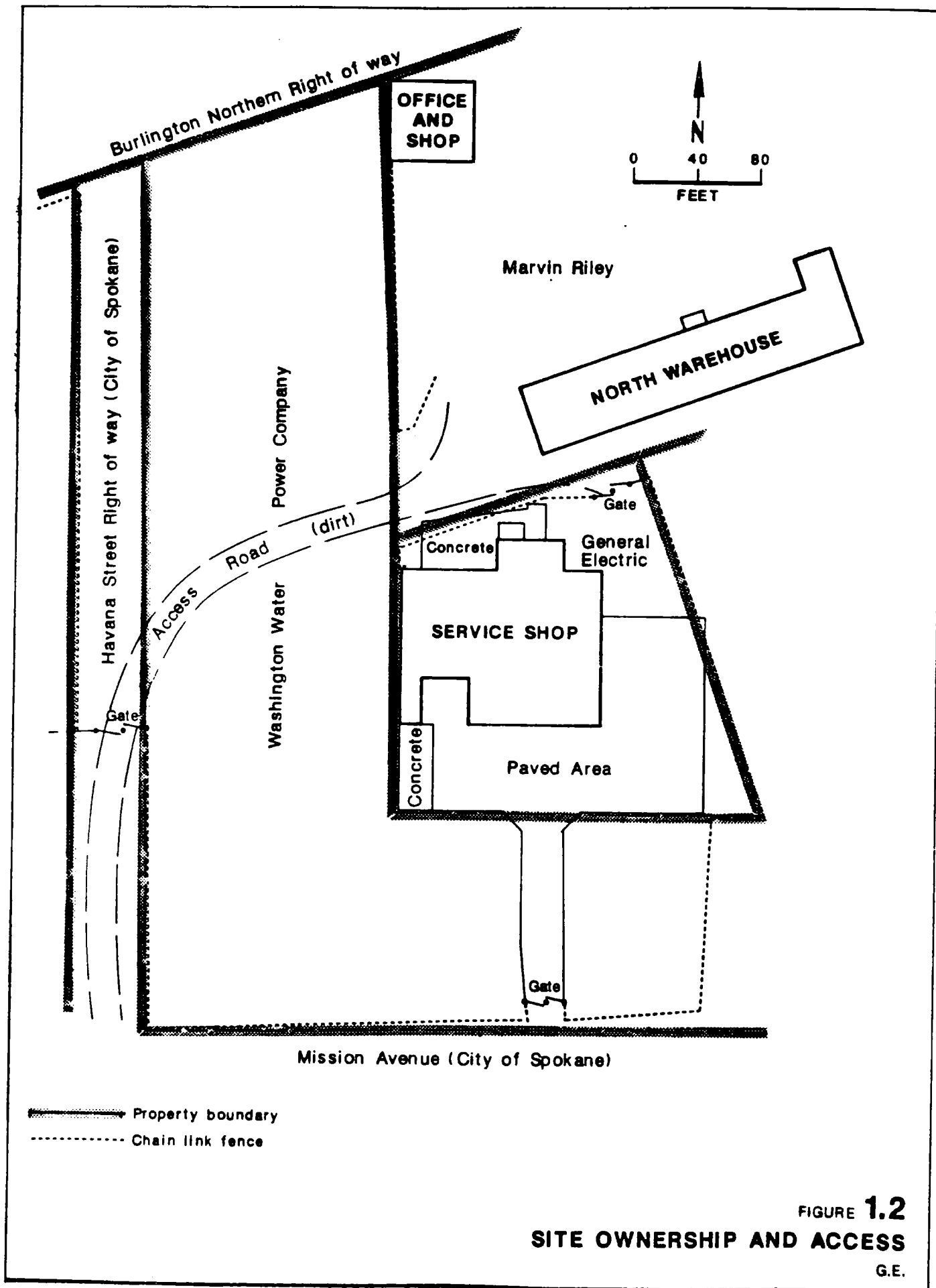


FIGURE 1.2  
**SITE OWNERSHIP AND ACCESS**  
 G.E.

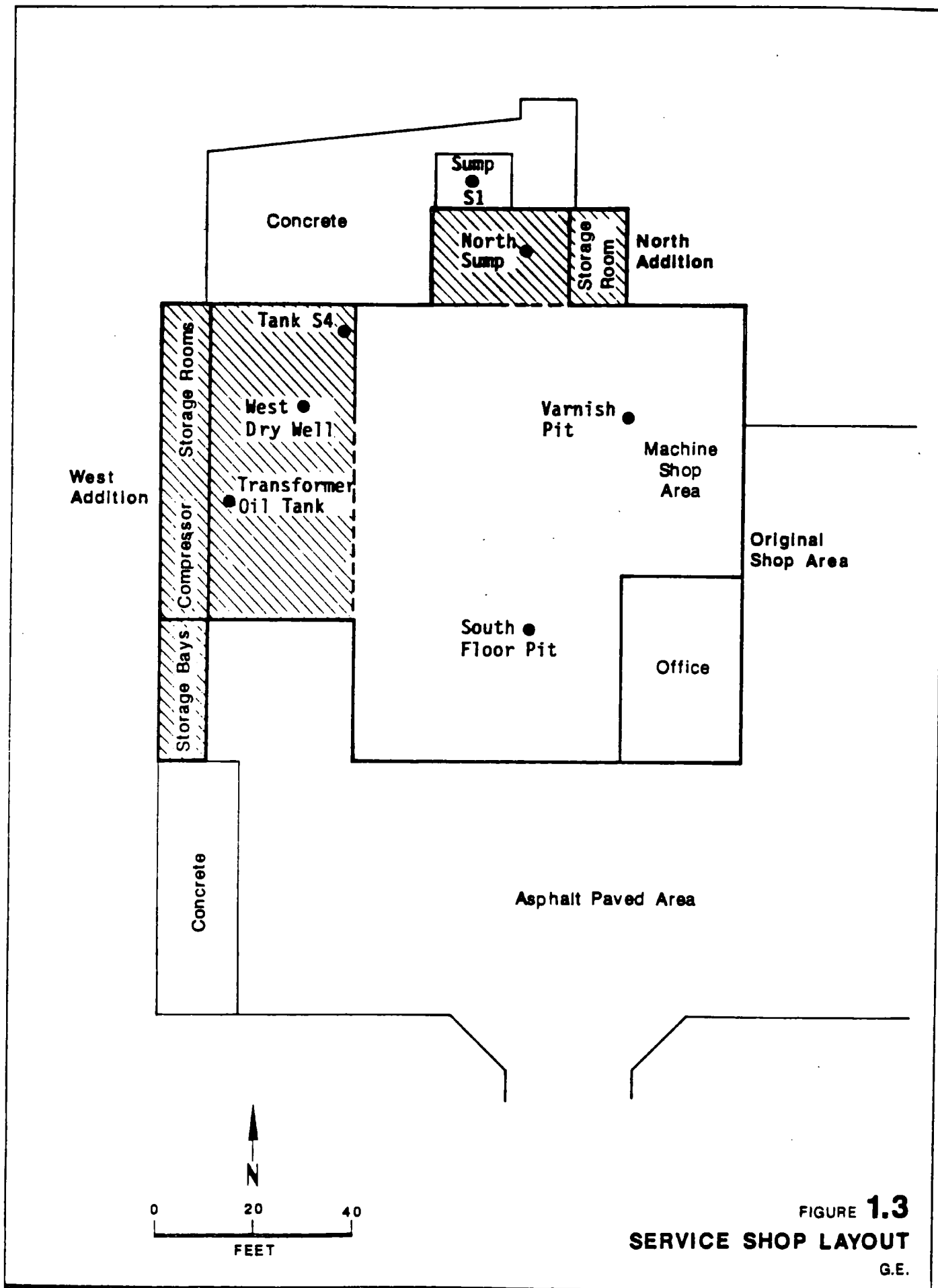


FIGURE 1.3  
SERVICE SHOP LAYOUT  
G.E.

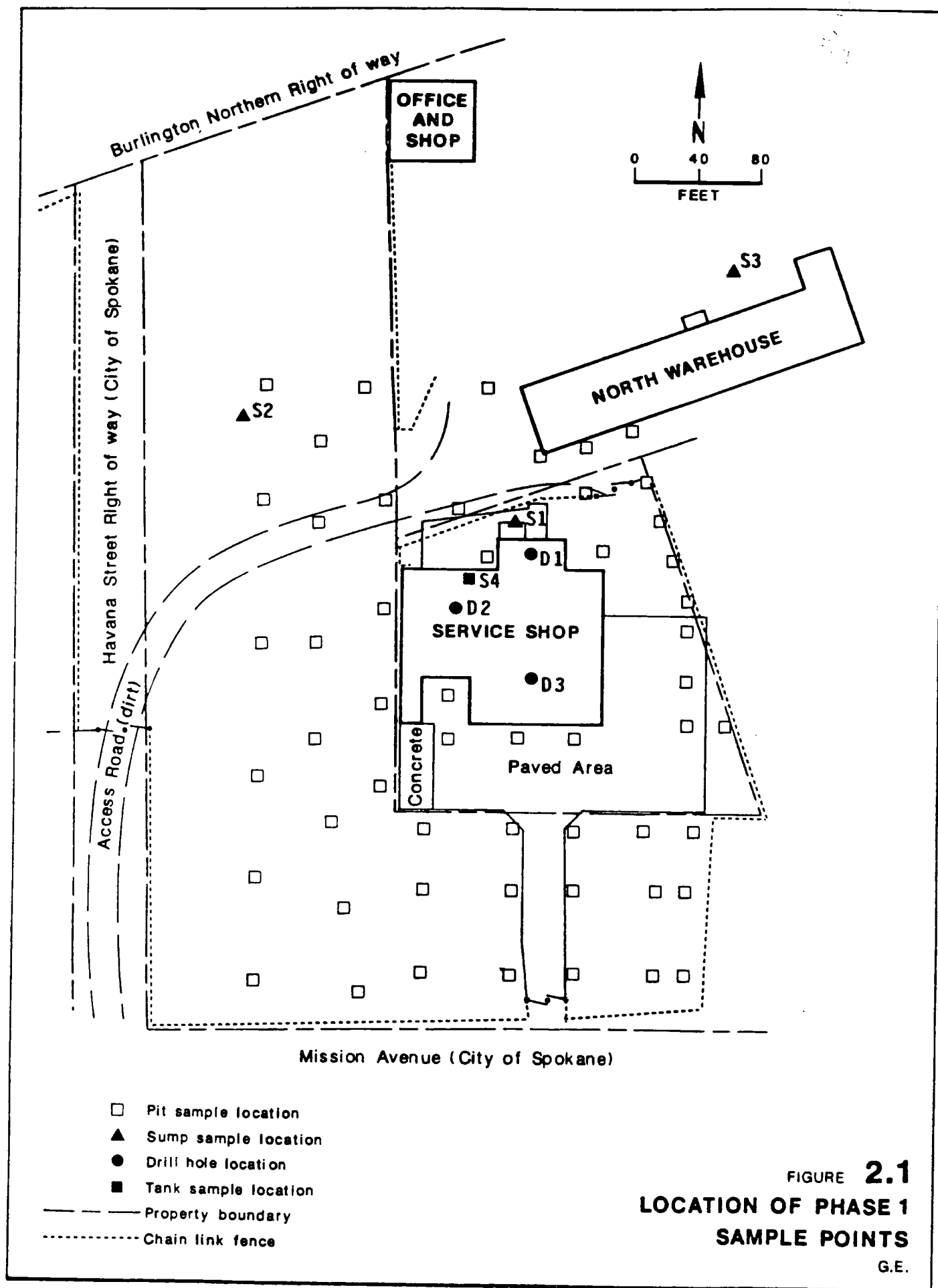
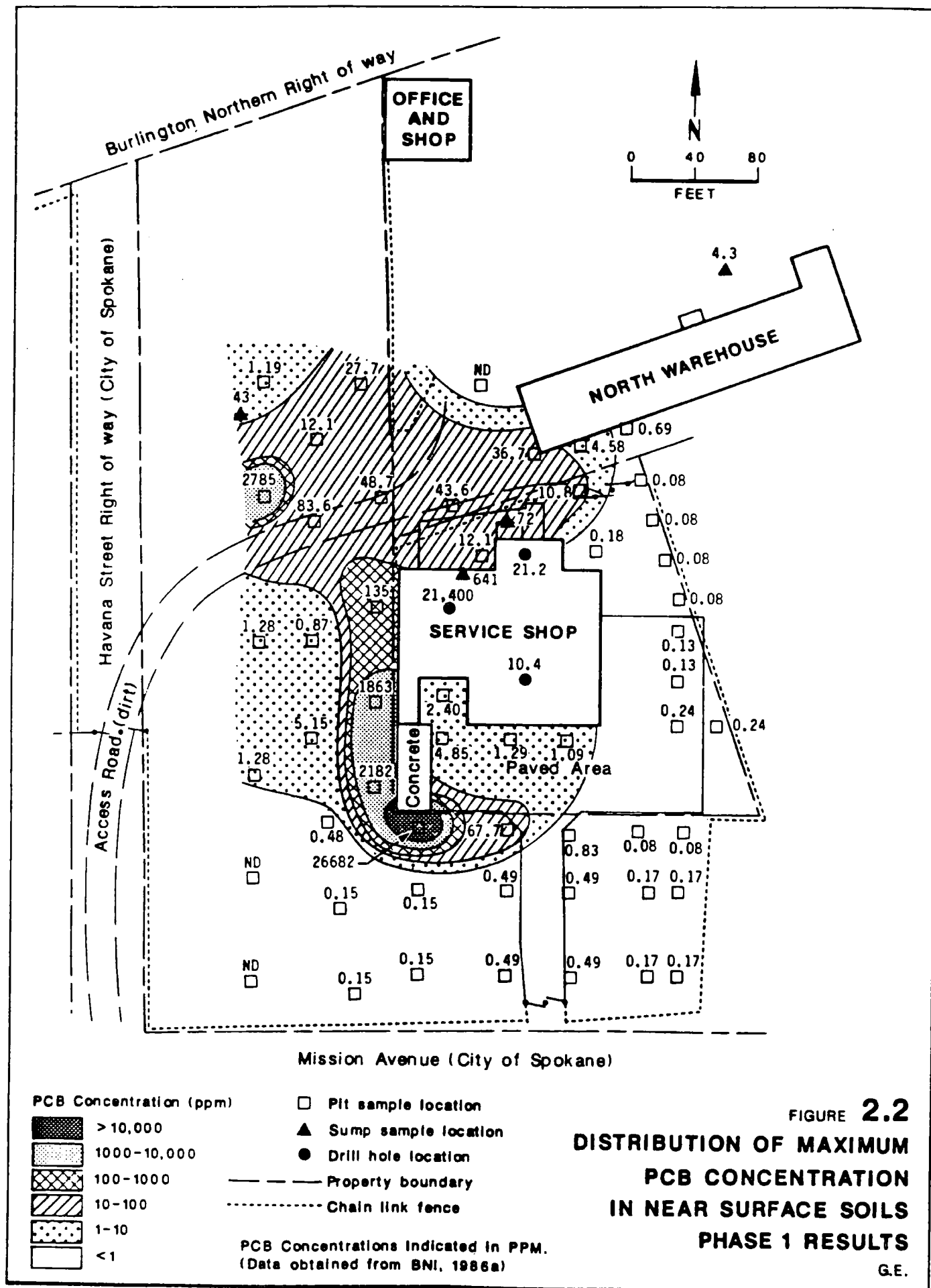
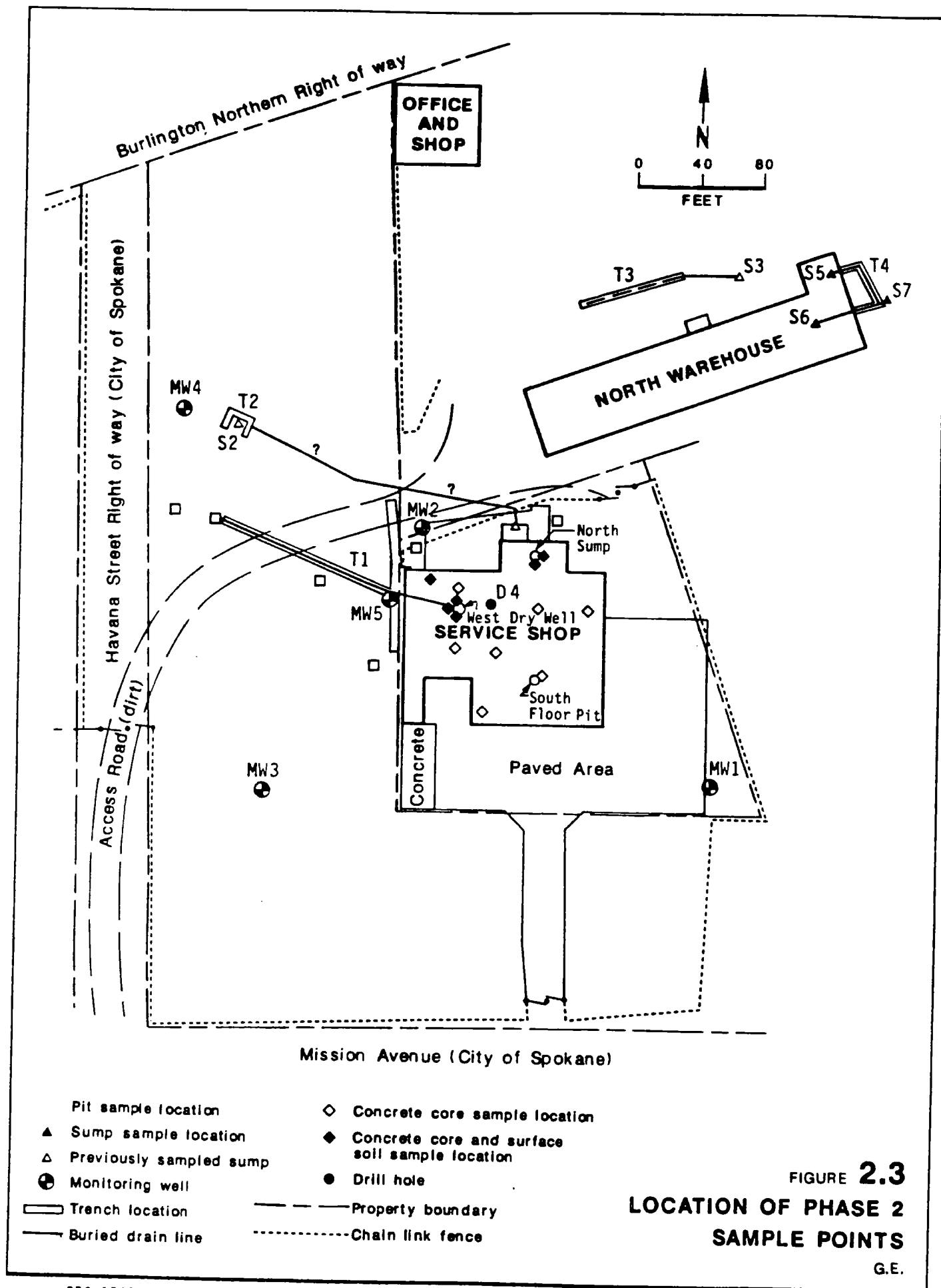


FIGURE 2.1  
LOCATION OF PHASE 1  
SAMPLE POINTS  
G.E.





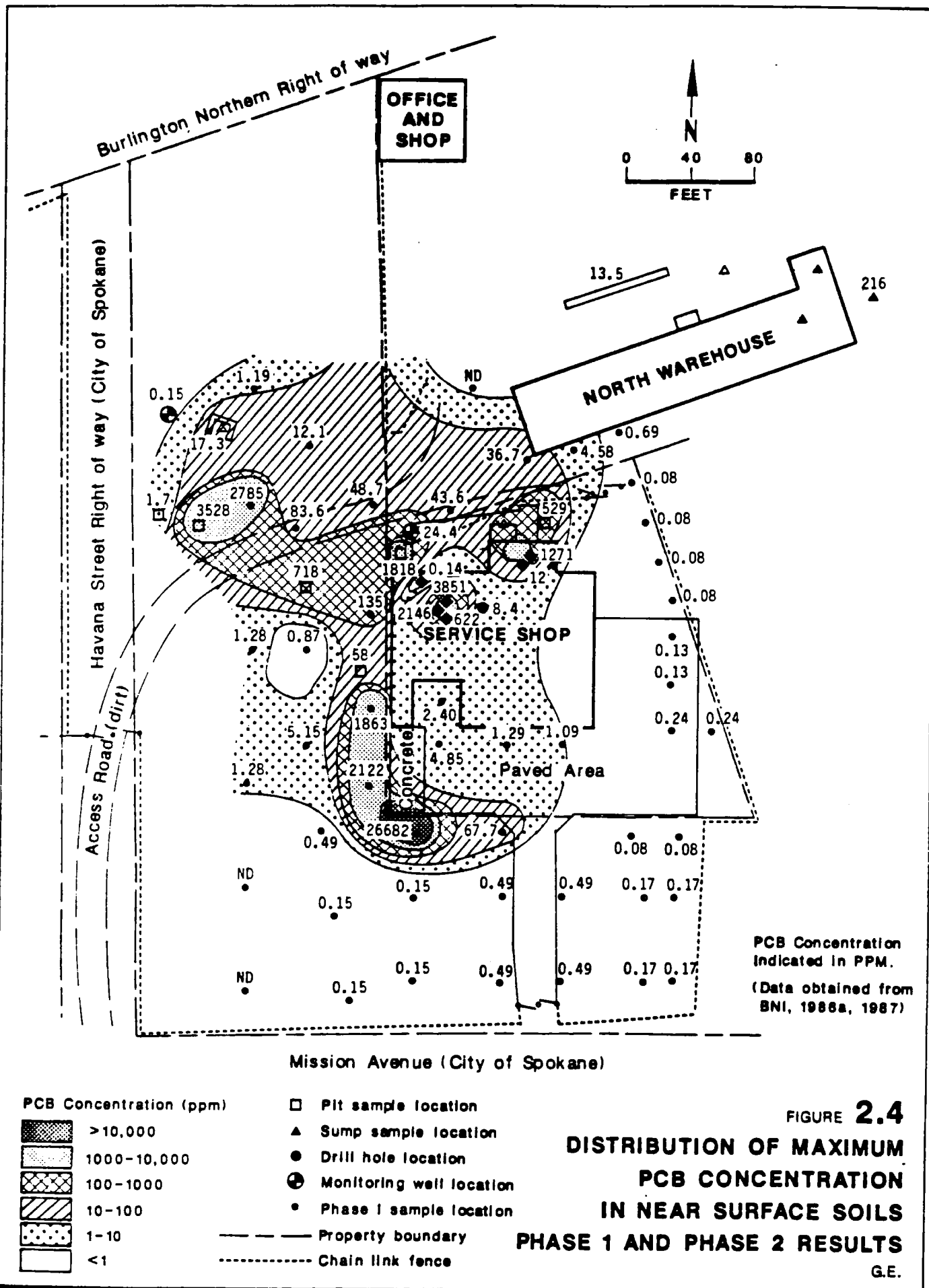
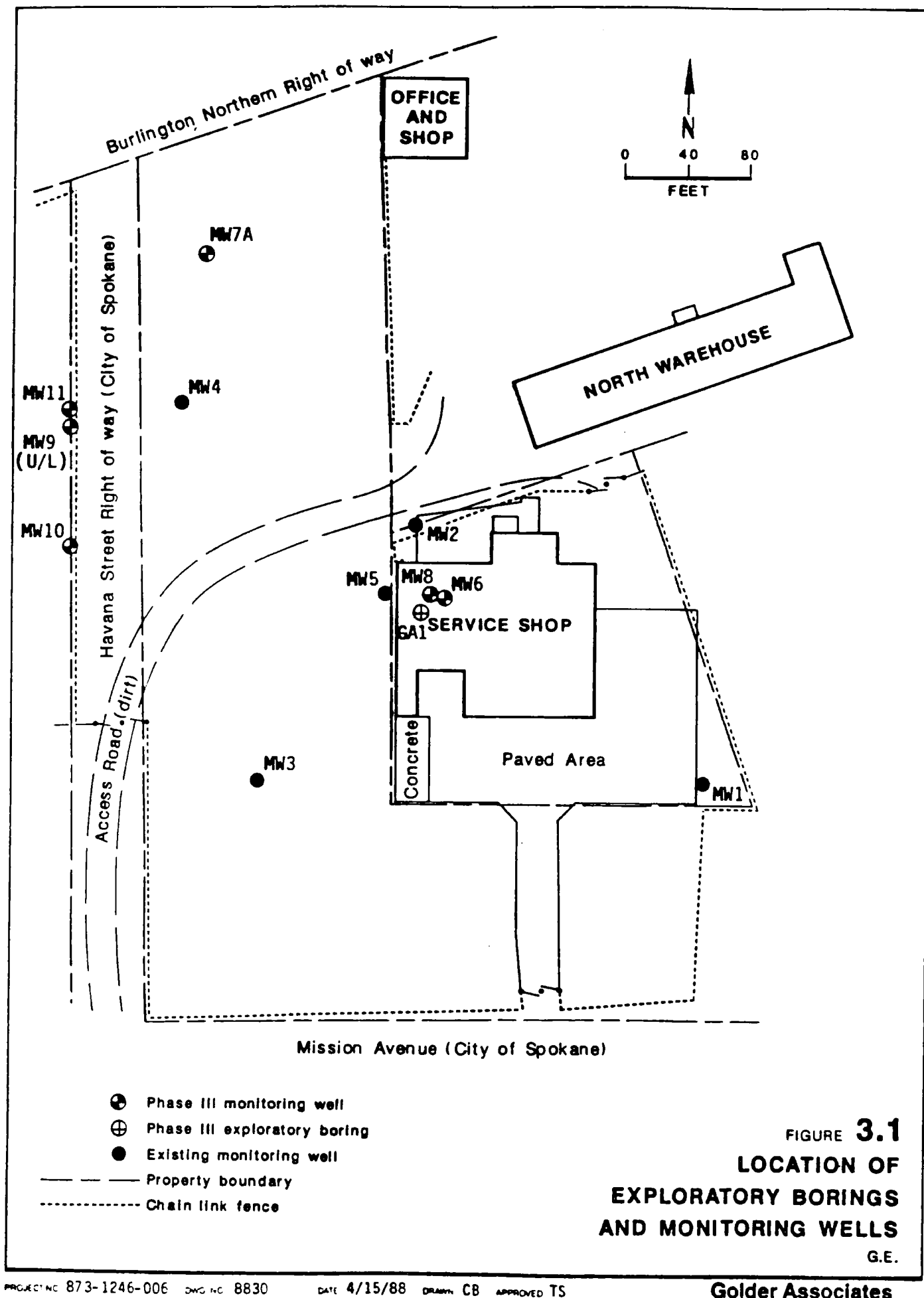
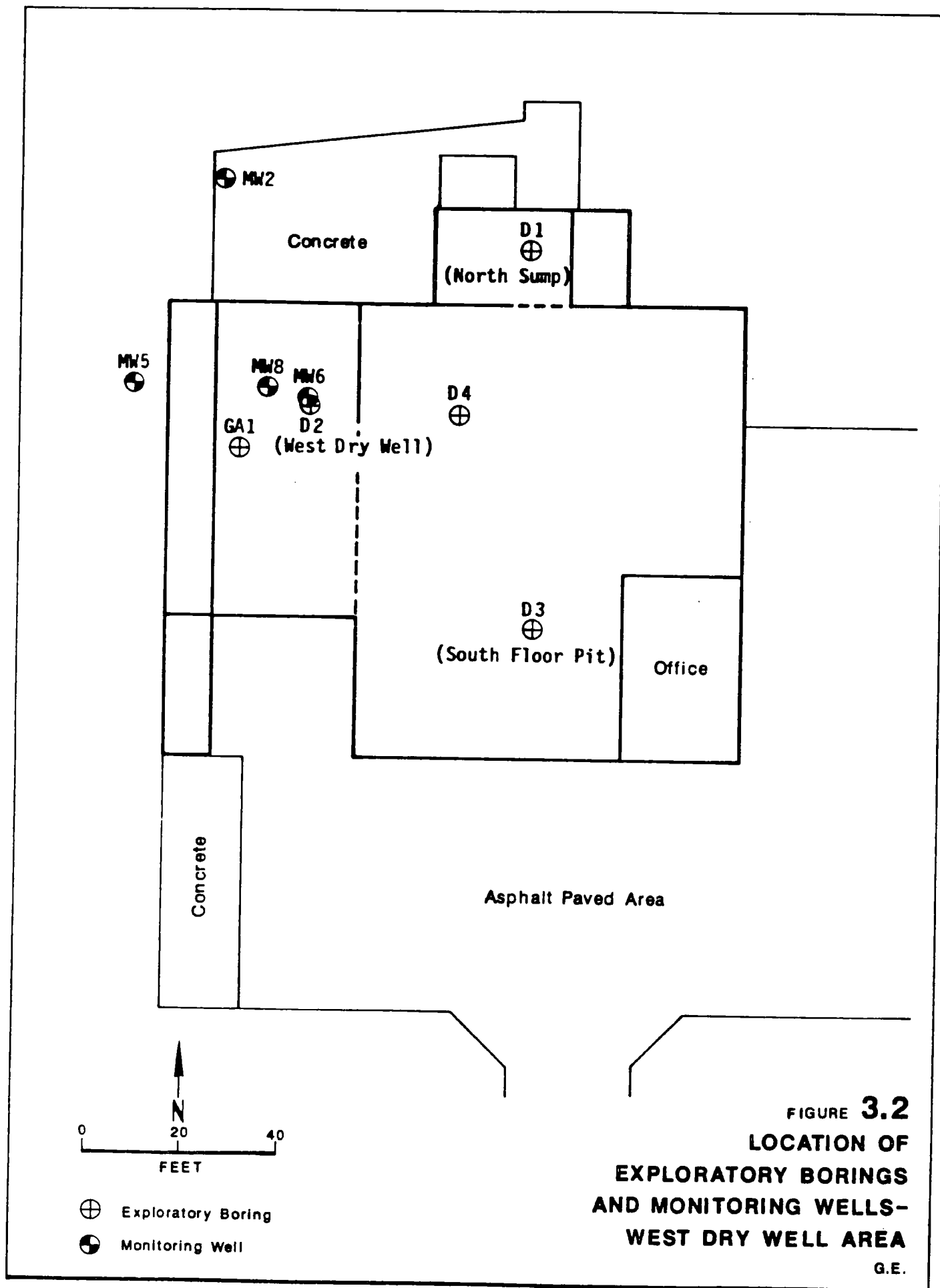


FIGURE 2.4  
DISTRIBUTION OF MAXIMUM  
PCB CONCENTRATION  
IN NEAR SURFACE SOILS  
PHASE 1 AND PHASE 2 RESULTS  
G.E.

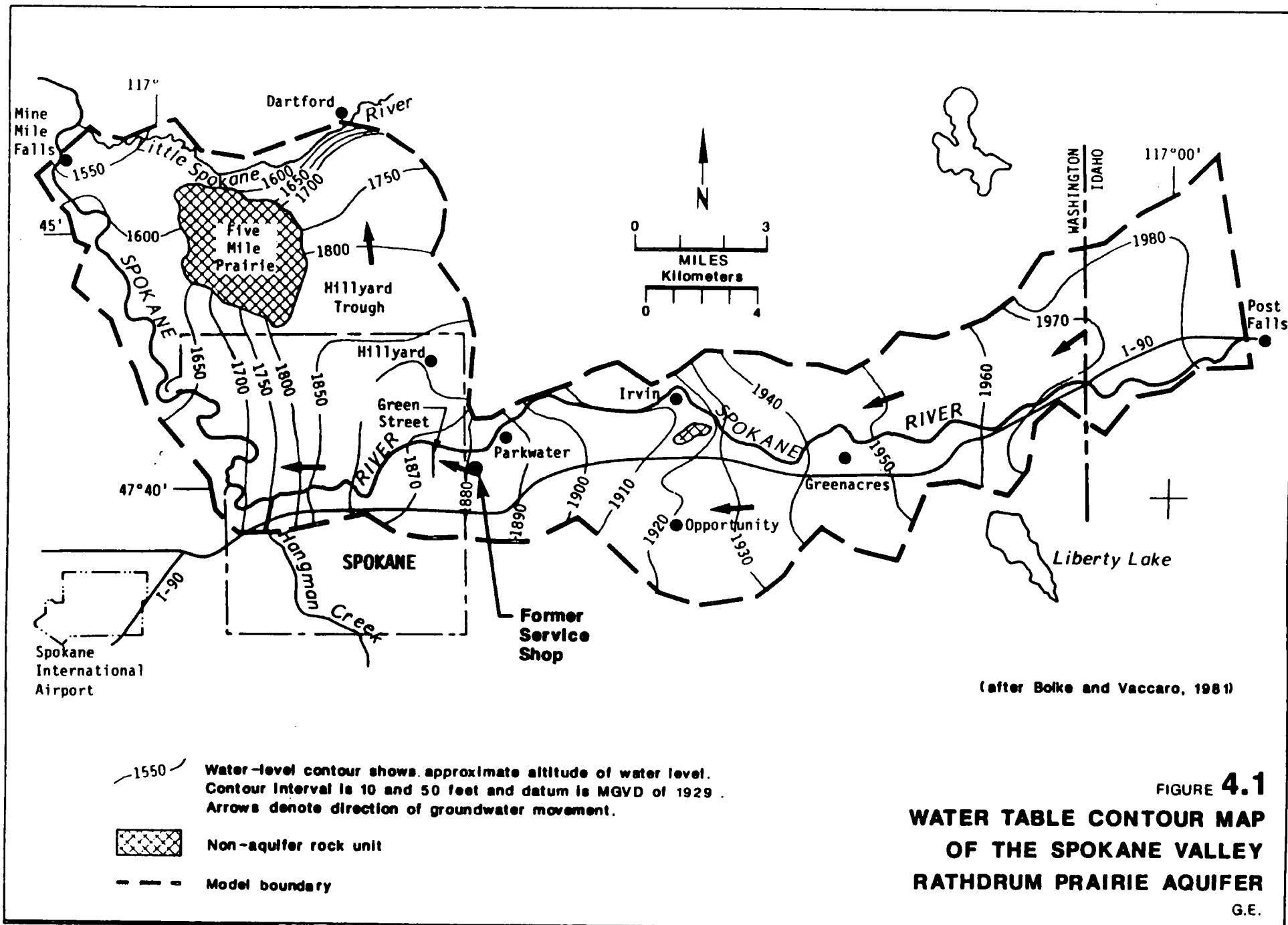


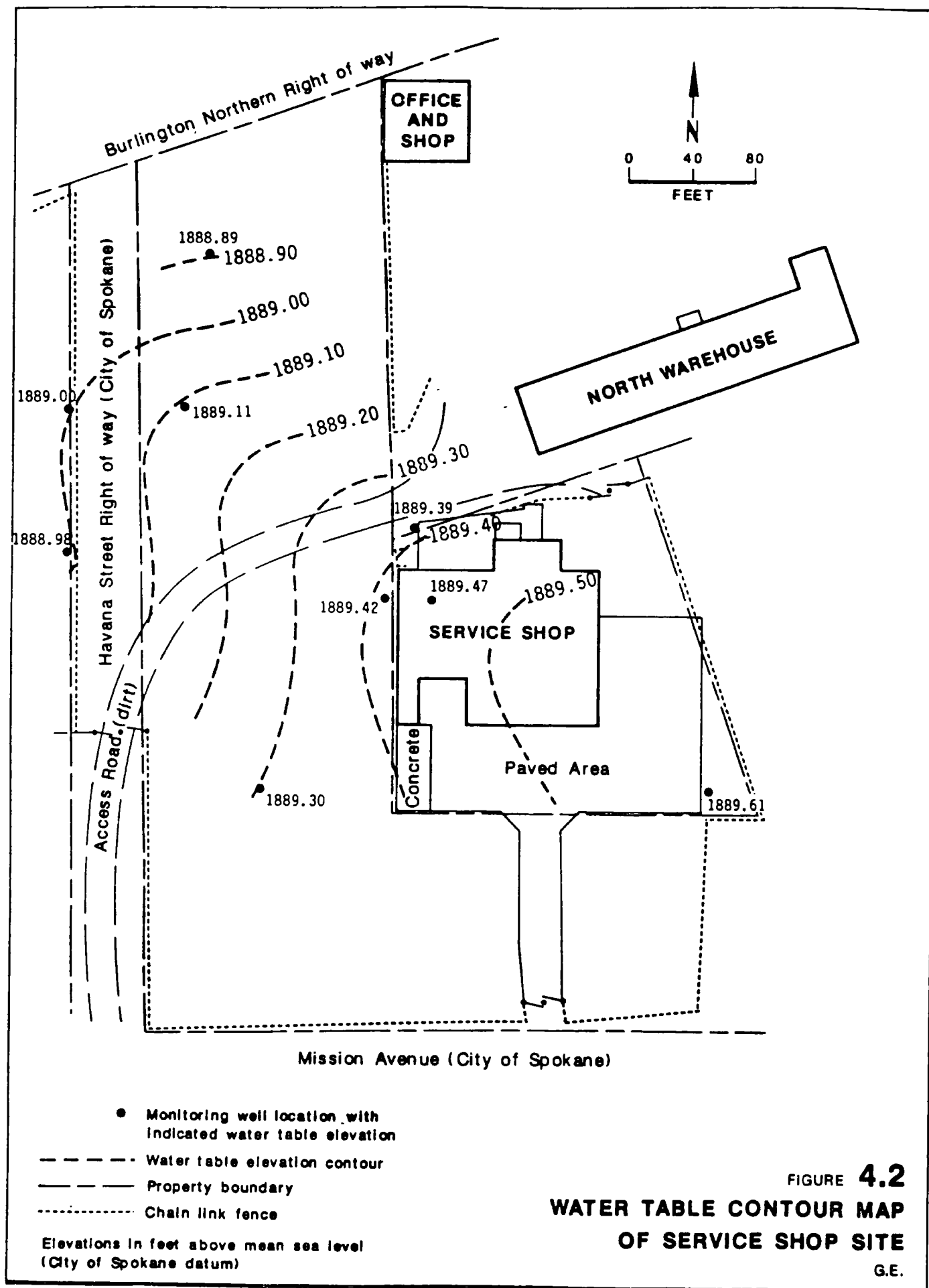


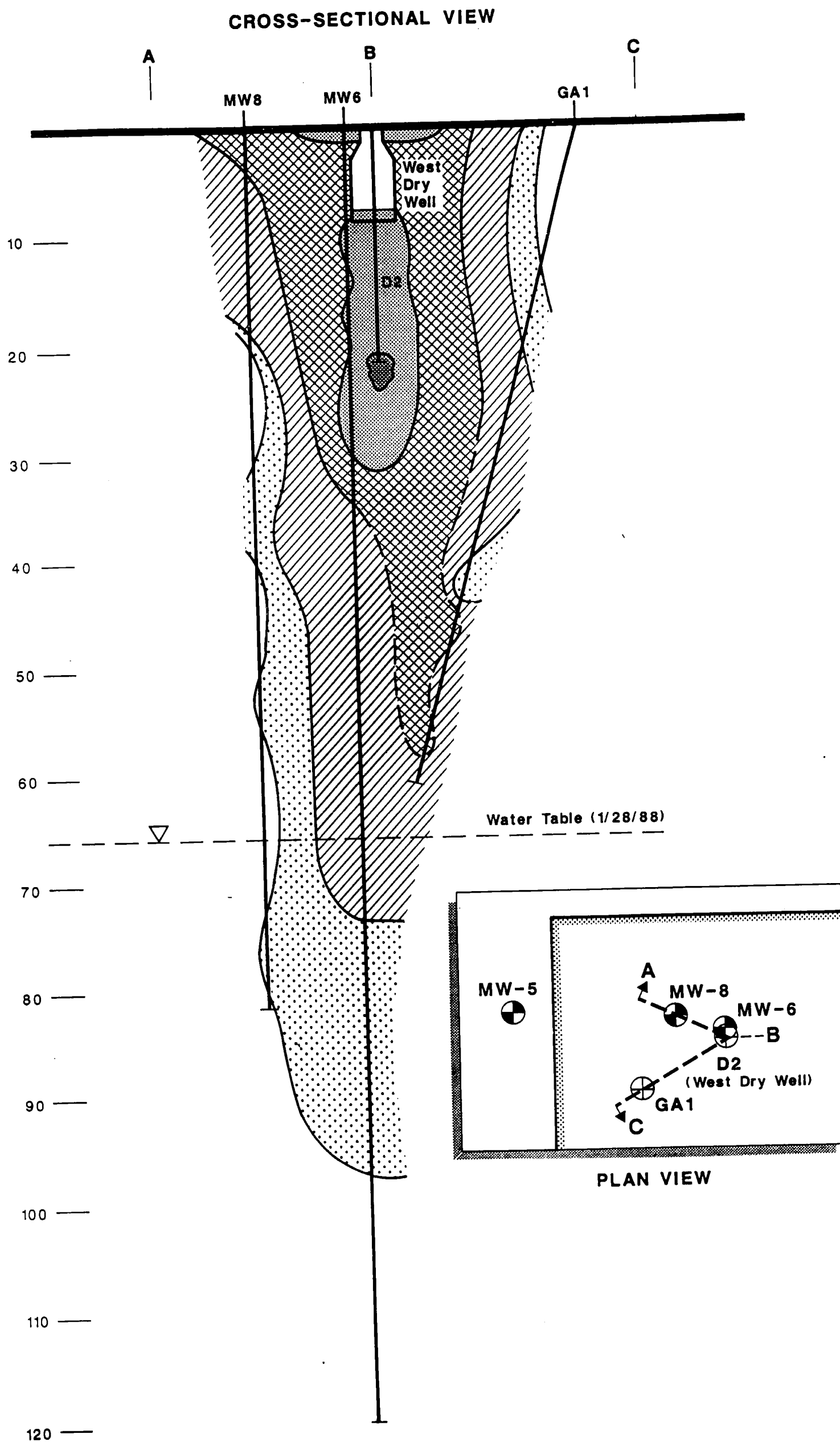
**FIGURE 3.2**  
**LOCATION OF**  
**EXPLORATORY BORINGS**  
**AND MONITORING WELLS-**  
**WEST DRY WELL AREA**

G.E.



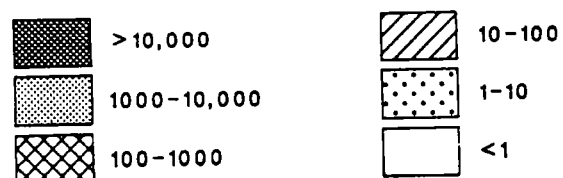






Horizontal Scale - Vertical Scale

PCB Concentration (ppm)



Profiles based on maximum probable extent of indicated PCB concentration and include local zones of lower PCB concentration.

FIGURE **4.3**  
**PROFILE OF PCB CONCENTRATION  
IN WEST DRY WELL AREA**

G.E.

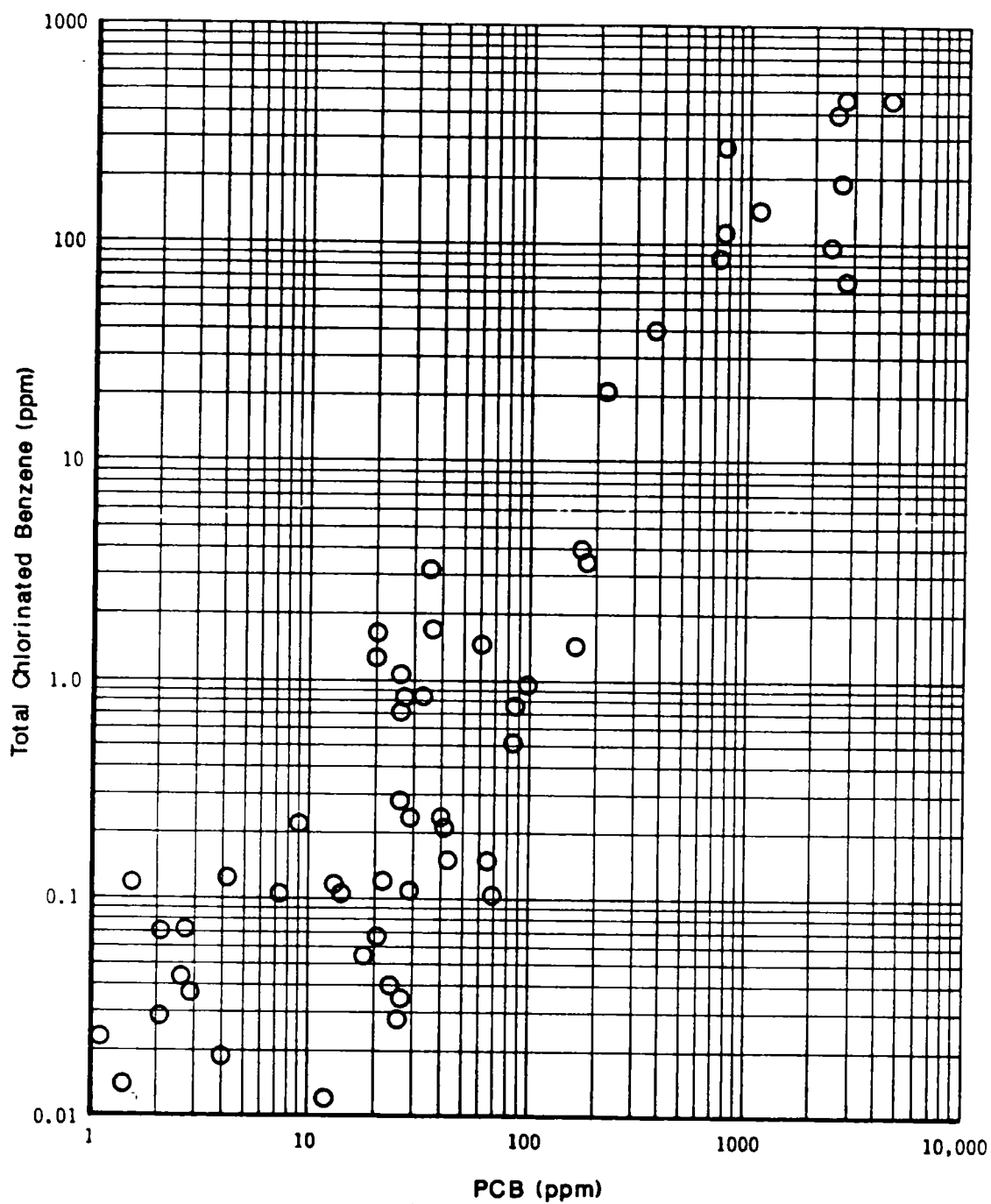


FIGURE 4.4  
CORRELATION BETWEEN PCB  
AND CHLORINATED BENZENES  
G.E.

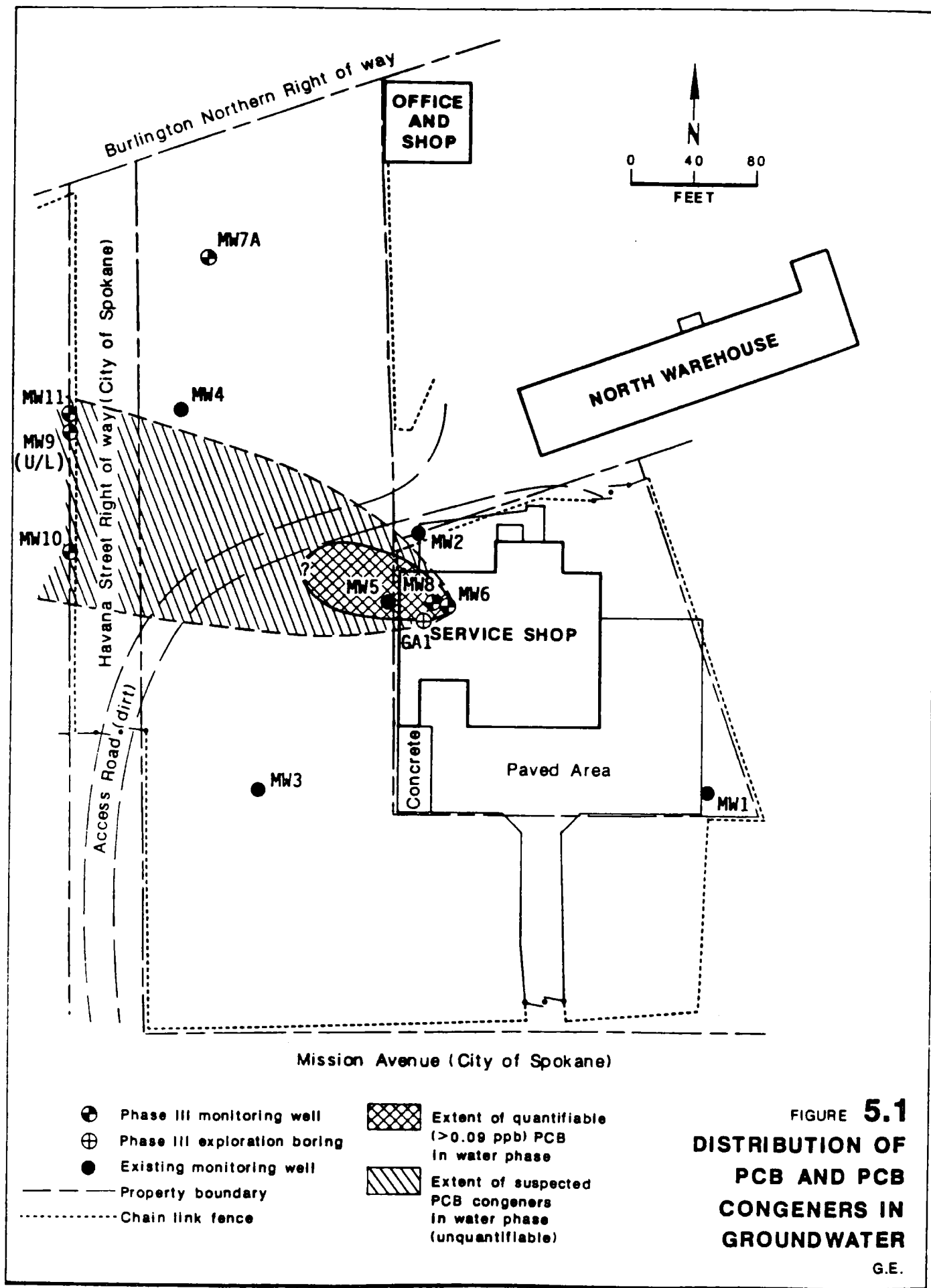


FIGURE 5.1  
DISTRIBUTION OF  
PCB AND PCB  
CONGENERS IN  
GROUNDWATER

G.E.

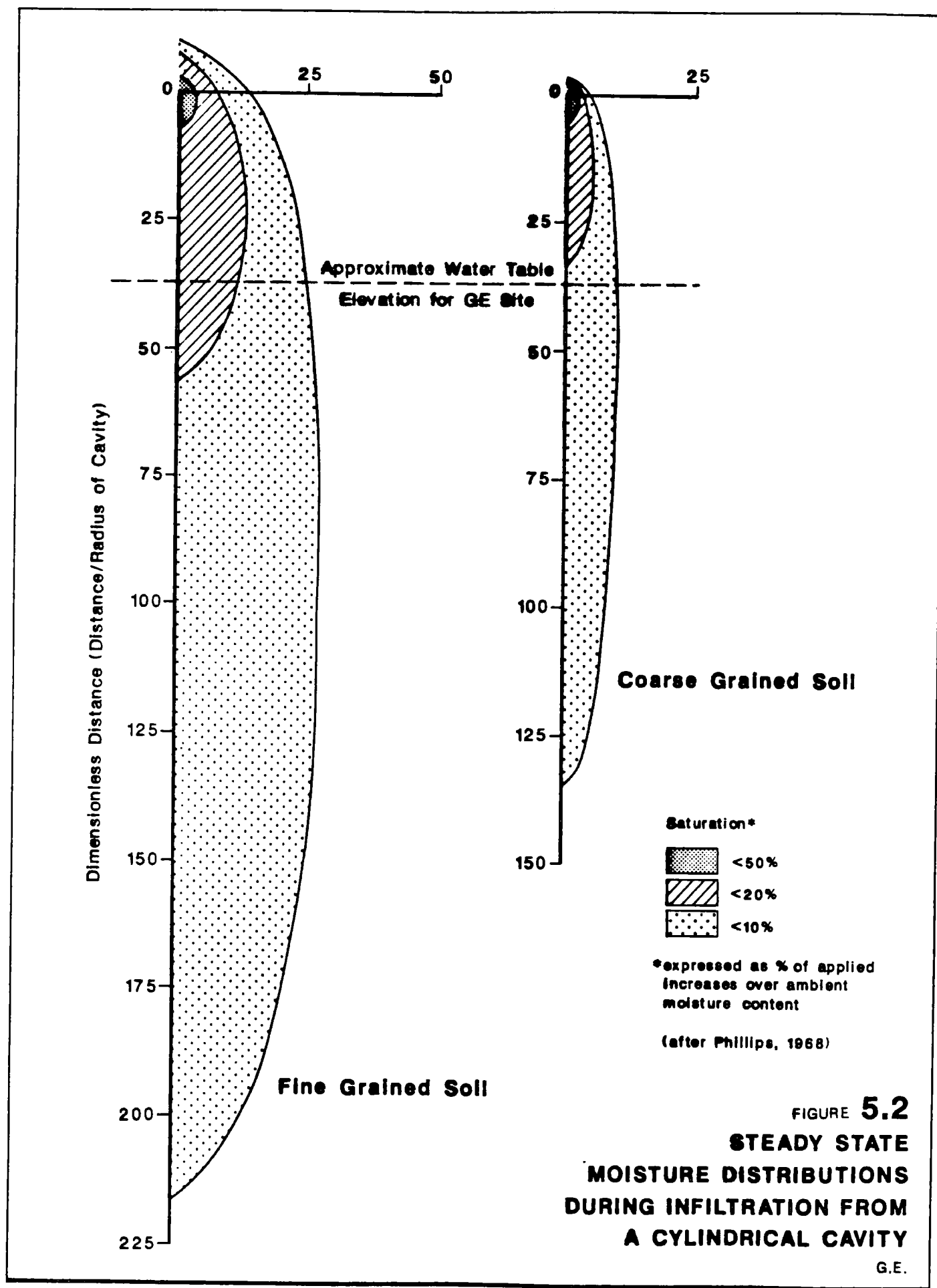


FIGURE 5.2  
STEADY STATE  
MOISTURE DISTRIBUTIONS  
DURING INFILTRATION FROM  
A CYLINDRICAL CAVITY

G.E.